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Title

ADVANCED VERY HIGH RESOLUTION RADIOMETER / 3 INSTRUMENT INTERFACE CONTROL DOCUMENT

AVHRR/3 ICD

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TBC / TBD LISTS

This document includes several TBD (to be defined) and TBC (to be confirmed) on the following pages.

TBD_{AVH} on Pages	TBC_{AVH} on Pages
2.15 2.19 2.29 2.33	2.23 2.31 2.32 2.33
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4.2 4.4	-
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TBD_{MET} on Pages	TBC_{MET} on Pages
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1. GENERAL INFORMATION

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1.1. GENERAL

1.1.1. Purpose of the Document

This document is the AVHRR/3 Instrument Interface Control Document. It deals with the. interface definition between the instrument and the METOP satellite.

The ICD document forms the unique formal definition on engineering, ground and flight operations for the METOP programme, specifying the binding requirements between ESA and the Instrument Supplier. It is configuration controlled by the METOP project team and formally signed off by ESA, the Instrument Supplier and the METOP prime contractor.

As a single point control of the technical interfaces, the ICD :

- Defines the technical resources allocated to the instrument.
- Defines the detailed mechanical, thermal and electrical interfaces between the instrument and the satellite.
- Defines the design verification programme which shall be implemented to demonstrate compliance with the METOP / AVHRR/3 interface requirements.
- Defines the detailed mechanical, electrical and protocol interfaces between the instrument ground support equipment and the METOP PLM ground support equipment.
- Defines the operational interface applicable during ground, launch and flight phases.

The objective of the ICD is to ensure that :

- The instrument is designed, built and verified within the constraints imposed by the overall payload complement, satellite and launch vehicle,
- The satellite Prime Contractor is able to design build and verify the satellite in such a manner that all instruments can be successfully integrated into the system,
- The spacecraft system can be successfully launched and operated to achieve the mission objectives of the METOP programme.

1.1.2. Documentation

In cases of conflict between the following applicable documents and the present ICD, the agreement or definition in this AVHRR/3 ICD shall govern.

1.1.2.1. Applicable Documentation

AD 1. METOP Product Assurance Requirements for NOAA Instruments
Ref. MO-RS-ESA-PA-0065

AD2. METOP Finite Element Model Requirement Specification For Structural Analyses
Ref. MO-RS-MMT-SY-0008

AD3. Satellite Thermal Model Requirement Specification, Ref. MO-RS-MMT-SY-0009

AD4. Electromagnetic Interference Characteristics, Measurement of, **MIL-STD-462C**.

AD5. ~~NOAA Instrument GSE-to-METOP Interface Requirements, Ref. GSFC S-480-91.~~ VOID

AD6. **AVHRR/3** Instrument Thermal Interface Mathematical Model Report, Ref. **SAI-RPT-084**

AD7. **AVHRR/3** Instrument Thermal Interface Mathematical Model (Ref. **LTS/0200/BB**)

ADS. Reduced Model of AVHRR Baseplate for **ESA Thermal** Elastic Analysis, - Ref. S-TIROS-TJB-96-0064 (included in **LTS/0312/BB)**

AD9. AVHRR Thermo-Elastic Model (Ref. **TBD$_{MET}$)**

AD10. PLM EGSE Internal Interface Control Document, Ref. MO-ID-DOR-PM-0018.

AD11. Void

AD12. Space Clamp Target **Assy** (Drawing), Ref. 8120858

AD13. T/V Integration Targets (Drawing), Ref. 8122606

AD14. Cryo Assy AVHRR (= Bench Cooler), Ref. 8170775

AD 15. AVHRR Bench Test Assembly, Ref. 8 177783

1.1.2.2. Reference Documentation

RD1. Performance Assurance Requirements for the NOAA-K, L **& M AVHRR/3** and **HIRS/3** Ref. S-480-29.1, Rev. G, dated March 1990

RD2. Performance **Specification** for the NOAA-N, **N'** and **METOP-1 AVHRR/3** Ref. S-480-27.3 Rev. C, dated May 1993

RD3. **ATN-K,L,M** General **Instrument** Interface Specification Ref. IS-3267415, Rev. C, dated October 1991

RD4. Unique Interface Specification for the **AVHRR/3** Ref. IS-20029950, Rev. C, dated July 93.

RD5. Void

RD6. Void

RD7. Void

RD8. Void

RD9. **METOP** GSE Requirements, **ITT** Technical Note, Dated **May 15th 1996** (M. WEBB)

RD10. Shroud **Assy** AVHRR (Drawing), Ref. 8121088

RD11. Requirements for the Data Acquisition Block for NOAA Instruments, Ref. MO-RS-DOR-PM-0025.

RD12. Final Report for TIROS Instruments Dynamic Analysis (Opening of Radiant Cooler Door), Ref. SDRC 19150

1.13. Acronym List

AD	Applicable Document
A-DCS	Advanced Data Collection System
AIT	Assembly, Integration & Test
AIV	Assembly, Integration & Verification
AMSU-Al	Advanced Microwave Sounding Unit 1
AMSU-A2	Advanced Microwave Sounding Unit 2
ARGOS	Meteorological Data Collection and Location System
ASCAT	Advanced Wind Scatterometer
AVHRR/3	Advanced Very High Resolution Radiometer
BOL	Beginning of Life
C&C	Command & Control
CAM	Coarse Acquisition Mode
CCU	Central Computer Unit (SVM)
CFI	Customer Furnished Instrument
CRA	Combined Receive Antenna (A-DCS, SARR, SARP-3)
DBU	Digital Bus Unit
DC	Direct Current
DSPG	Distributed Single Point Grounding
DTA	DCS Transmit Antenna
EGSE	Electrical Ground Support Equipment
EMC	Electromagnetic Compatibility
EMI	El-magnetic Interference
EOL	End of Life
FAM	Fine Acquisition Mode
FEM	Finite Element Model
FMECA	Failure Modes, Effects and Criticality Analysis
FMU	Formatting and Multiplexing Unit
FOV	Field of View
'FPM	Fine Pointing Mode

Gbit	Gigabits
GNSS	Global Navigation Satellite System
GOME-2	Global Ozone Monitoring Experiment
GRAS	GNSS Receiver for Atmospheric Sounding
GSE	Ground Support Equipment
H/W	Hardware
HIRS/4	High Resolution Infra-Red Radiation Sounder
HK	House Keeping
HRPT	High Resolution Picture Transmission
I/F	Interface
IASI	Infra-red Atmospheric Sounding Interferometer
ICD	Interface Control Document
ICU	Instrument Control Unit
IR	Infrared
IST	Integration System Test
kbps	kilobits per second
KLM	NOM K, L, M series of satellites
LEOP	Launch and Early Orbit Phase
LRPT	Low Resolution Picture Transmission
Mbps	Megabits per Second
MCMD	Macro command
MGSE	Mechanical Ground Support Equipment
MHS	Microwave Humidity Sounder
MIL	Military (standard)
N/A	Not Applicable
NIU	NOAA Instrument Interface Unit
OBDH	Onboard Data Handling System
OCM	Orbit Control Mode
OCOE	Over Check-Out Equipment
OMI	Ozone Monitoring Instrument
P/F	Platform
P/L	Payload
PA	Product Assurance
PCU	Power Conversion Unit
PLM	Payload Module
PMC	Payload Module Computer

RD	Reference Document
RF	Radio Frequency
RFC	Radio Frequency Compatibility
rms	root mean square
rpm	round revolutions per minute
RRM	Rate Reduction Mode
Rx	Receive ; Receiver
S&R	Search and Rescue
SIC	Spacecraft
S/L	Satellite
S/S	subsystem
S/W	Software
SARP-3	Search and Rescue Processor
SARR	Search and Rescue Repeater
SEM-2	Space **Environmental** Monitor
SLA	S&R L-band Tx Antenna
SVM	Service Module
TB/TV	Thermal Balance / Thermal Vacuum
TBC	To be confirmed
TBCU	Transportable Bench **Check** Unit
TBD	Tobedefined
TC	Telecommand
TCU	Thermal Control Unit
TM	Telemetry
TT&C	Tracking, Telemetry, and Telecommand (**LEOP**, Emergency, and Stand-by)
Tx	Transmit, Transmitter
YSM	Yaw Steering Mode

1.2. INSTRUMENT PRESENTATION

1.2.1. General

(For information only)

Instrument Name	**AVHRR/3** **Advanced** Very High Resolution Radiometer / 3
Classification	Passive optical instrument

The AVHRR/3 is a six **channel** scanning radiometer, providing three solar channels in the visible-near infrared region and three thermal infrared channels. The instrument **utilises** an 8-inch diameter collecting telescope of the reflective **Mersenne** type. Cross-track scanning is accomplished by a continuously rotating mirror direct-driven by a **hysteresis.synchronous** motor. The three **thermal infrared** detectors are cooled to 105 deg. K by a two-stage passive radiant cooler.

The Sun angle is defined as the angle between the satellite to Sun line and the normal to the orbital plane with the spacecraft in its operating orientation. The **AVHRR/3** instrument, with the exception of the radiant cooler. operates within specification when exposed to any Sun angle from 0 to 80 deg. The radiant cooler operates within specification for solar angles between 0 to 68 deg. The spacecraft will provide shielding to the radiant cooler, compatible with the **METOP** orbit (see § 1.3.3 and 2.3.2.3.).

1.2.2. Scientific Objectives

(For information only)

The **AVHRR/3** scans the Earth surface in six spectral bands in the range of 0.58 - 12.5 microns. It provides day-night imaging of **land, water** and clouds, measures sea surface temperature, ice, snow and vegetation cover and characteristics.

The instrument uses an internal rotational scanning mirror which also views deep space and an internal calibration source. Those facilities (view to space and on-board black body targets) are used for the primary calibration of the IR channels **(3B,** 4 and **5),** which occurs at each scan cycle.

	Central Wavelength (µm)	Half Power Points (µm)	Channel Noise Specifications	lime **Availability**
1	***0.630***	***0.580 - 0.680***	**S/N 9:1 @ *0.5% albedo***	***24*** hours
2	0.862	0.725 - 1.000	**S/N 9:1 @** 0.5% albedo	24 hours
3a	1.610	1.580 - 1.640	**S/N** 20: 1 @ 0.5 % albedo	Day (Selectable)
3b	3.740	3.550 - 3.930	NEDT0.12 K @ 300K	Night (Selectable)
4	10.800	10.300 - 11.300	NEDT0.12 K @ 300K	24 hours
5	12.000	11.500 - 12.500	NEDT 0.12 K @ 300K	24 hours

***AVHRR/3** Channel Characteristics*

1.23. Functional Description

The AVHRR/3 consists of one unit with the following modules. These modules are illustrated in Figure 1.2.3/1.

133.1. Scanner Module

This module includes the scanning motor, the Beryllium mirror and the scan motor housing. or a brushless DC motor may be used.

The 80-pole two phase hysterisis synchronous motor, of The scan mirror rotates at aconstant 360 rpm rate. This causes the IFOV to scan scenes from space, through Earth, towards Sun direction.

1.23.2. Electronic Module

This module designates the individual electronic circuits that make up the AVHRR/3 electrical system A block diagram is given in 1.2.3/2.

Electronic Calibration

The AVHRW3 has two electronic calibration functions, the continuous ramp calibration mode (RAMP-CAL), and the commandable voltage calibration mode (VOLT-CAL, this one is not normally used in-orbit).

The RAMP-CAL is used to verify the linearity and gain of the instrument Analog-to-Digital (A/D) converter and amplifier electronics. The ramp calibration signal increases one step per revolution of the radiometer scanning system A ramp is generated every 1 024 scans. The direction of increase of the ramp is in the direction of increasing the radiance in each channel (i.e. low to high counts in the visible channels. and high to low counts in the infra-red channels).

The VOLT-CAL mode eliminates the detector signals and provides a three-point voltage calibration of the A/D converter and amplifier electronics. This is used mainly for troubleshooting in-orbit.

1.23.3. Radiant Cooler Module

The three thermal infra-red detectors are cooled by a two-stage passive radiator. They are mounted on a cold patch that has a 144 cm^2 (22.4 sq. in.) radiating area. This patch cools to less than 98 K with no control power. During nominal operation, its temperature is controlled at 105 K.

The radiant cooler module consists of the cooler housing, the first stage radiator, the patch or second stage radiator and the cooler door.

This door on the cooler assembly insulates the radiator from Earth direct thermal input. The door is released after the initial orbital outgas period. During the outgas / decontamination period, the cooler temperature rises to approximately 300 K.

The cooler door deployment mechanism is similar to a caging mechanism. Power is required only to release the shield by solenoid action after the spacecraft achieves operational orbit (single-shot solenoid, actuated by a spring driven deployment mechanism).

1.2.3.4. Optical Sub-system

The optical sub-system consists of a collecting telescope and a relay optics unit. Its characteristics are summarized as follows :

- Instantaneous field of view : 0.0745 deg. (square, ≈ 1.1 km)
- Earth view pixels per scan : 2048
- Swath (with respect to the nadir direction) : ± 55.37 deg.

1.2.3.5. Baseplate Unit

The baseplate unit is the common structure on which all other modules are mounted It is the physical interface to the satellite. It is also the major interface for the radiative thermal control of the instrument.

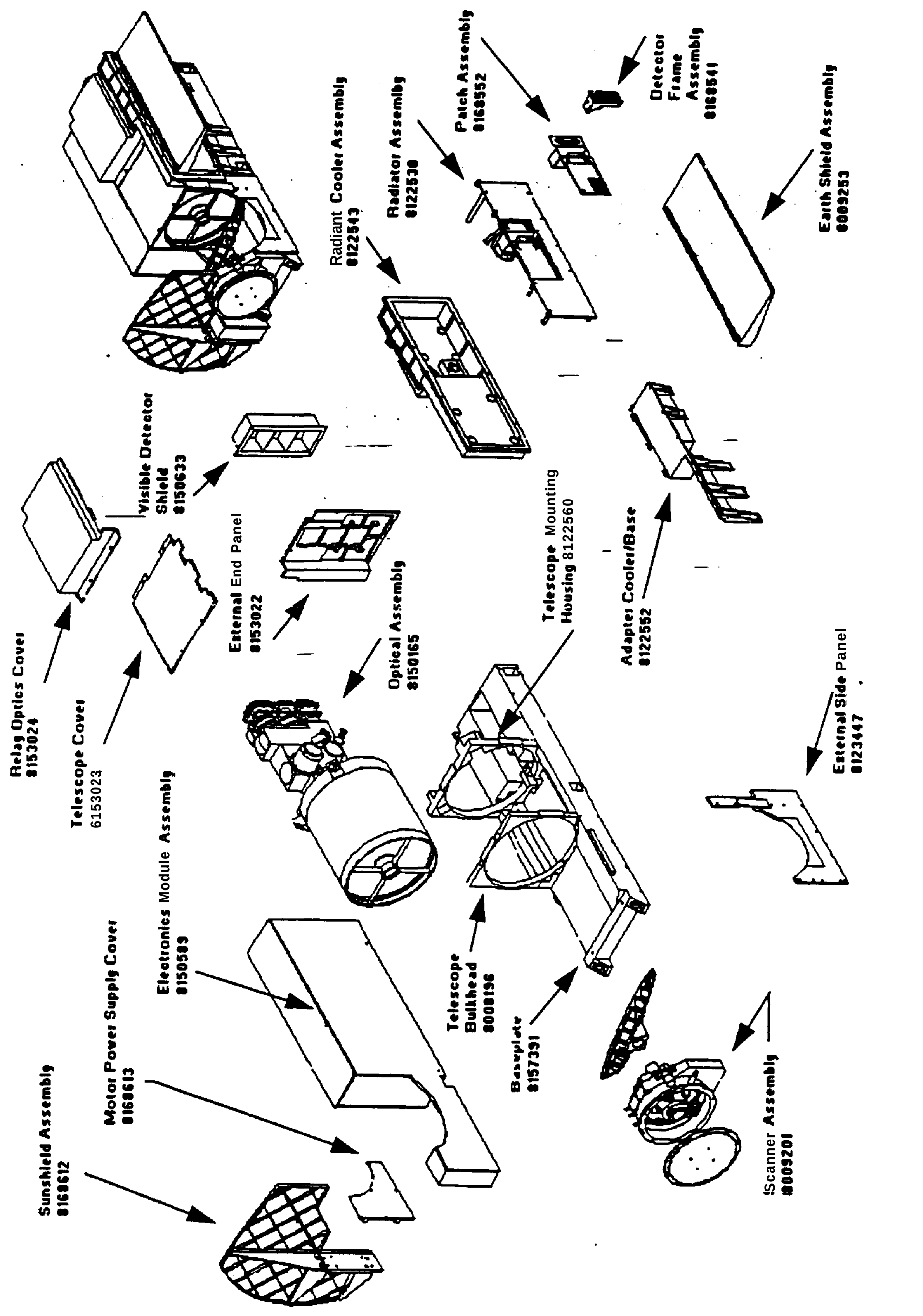


Figure 1.2.3/1 : AVHRR/3 Exploded View

SPACECRAFT INTERFACE

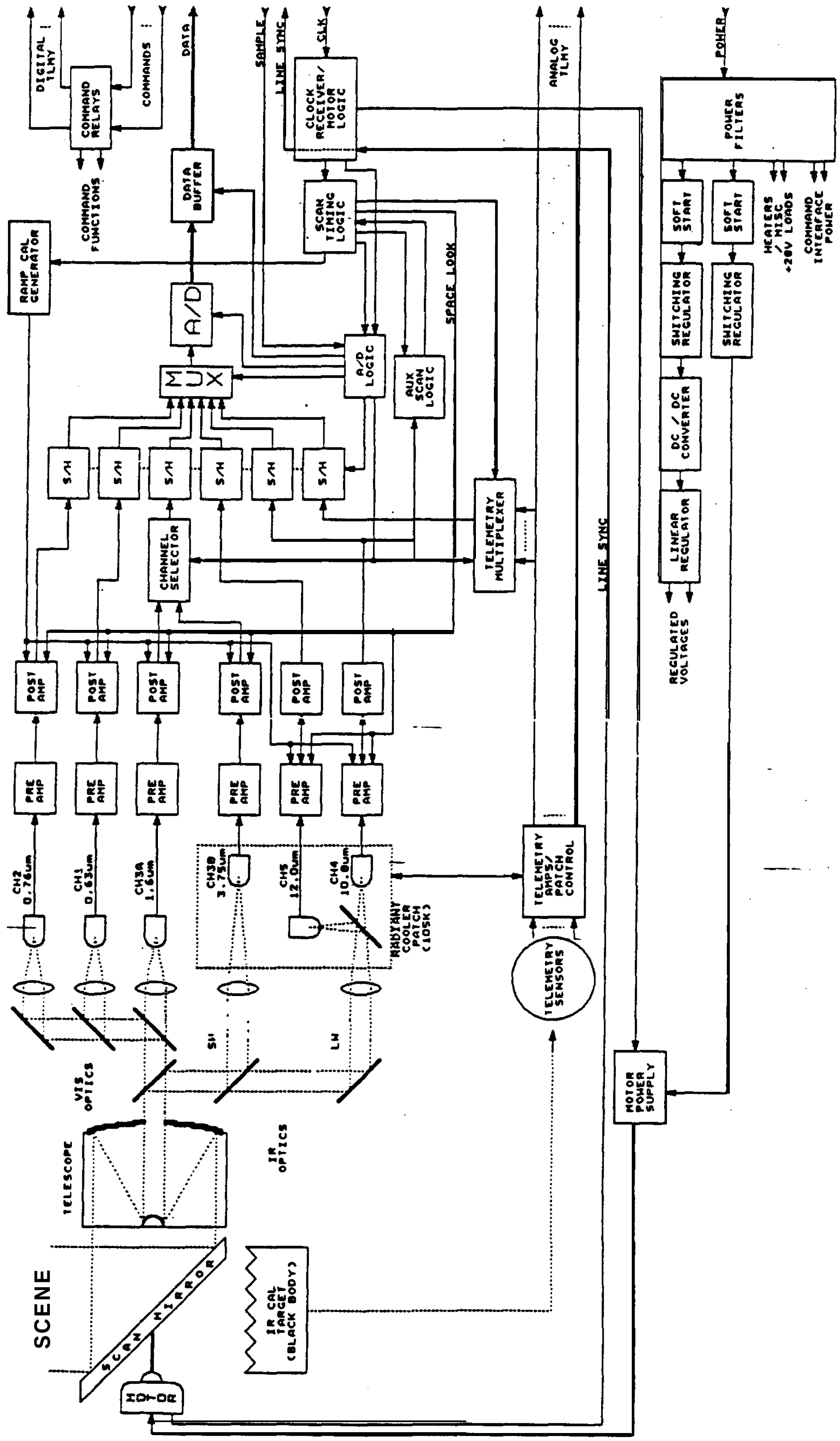


Figure 1.2.3/2 : AVHRR/3 Electronics Block Diagram

1.3. METOP SYSTEM OVERVIEW

13.1. Spacecraft Architecture Concept

(For information only)

The **METOP** mission consists of a **geocentric,** three-axis stabilized spacecraft placed into a **Sun-**synchronous orbit around the Earth. It is built around a primary structure consisting of :

- a service module **(SVM),** which provides all standard service elements
- an upper payload module **(PLM)** that accommodates the different instruments and corresponding electronic equipments.

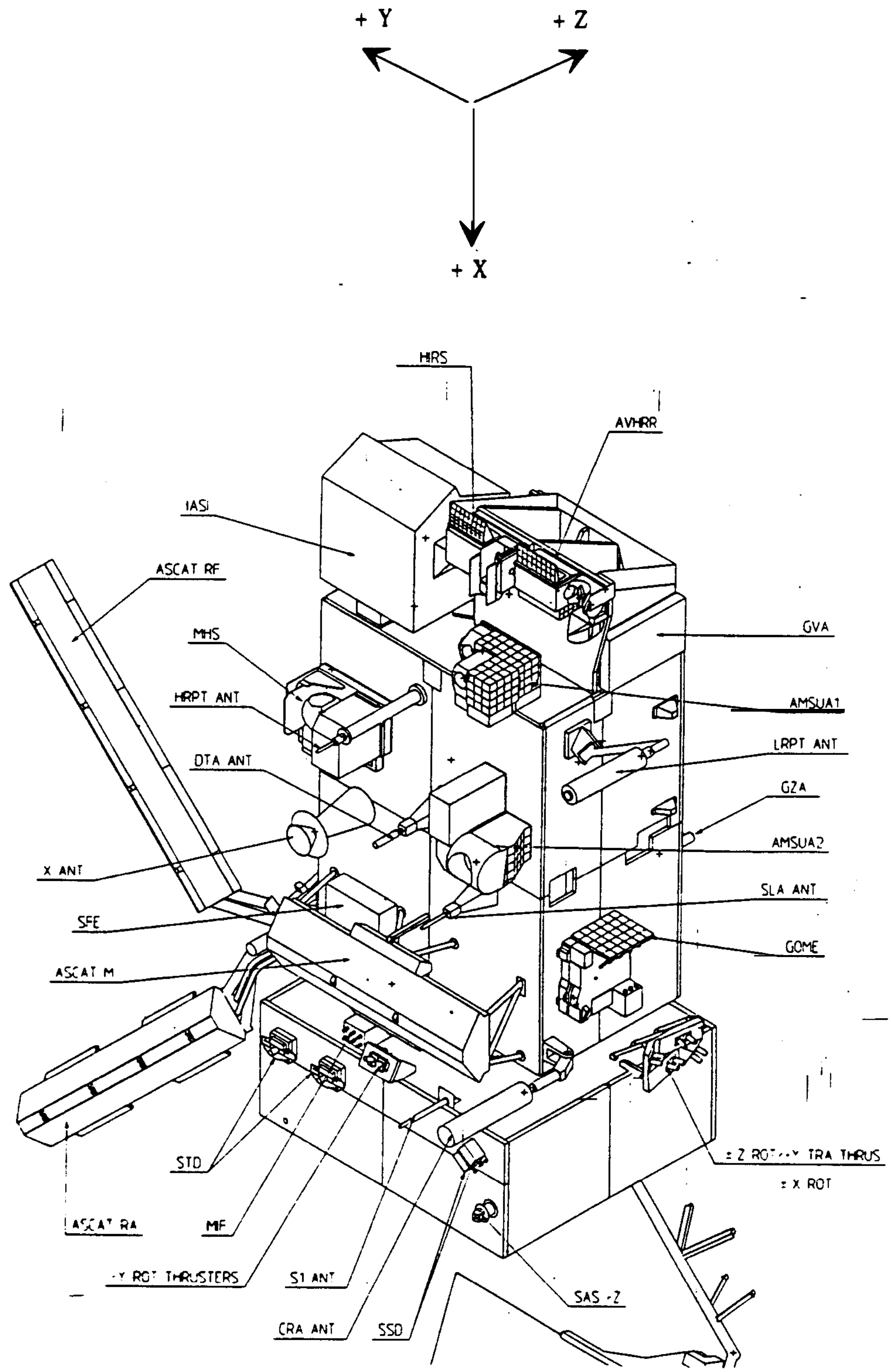
The service module is a box-shaped structure, that interfaces with the launch vehicle at the bottom and with the payload module at the top.

The payload module provides the main supporting structure and external panels on which are mounted the payload instruments. It also provides **internal** accommodation for both the payload support systems and the instrument electronic units.

The·METOP satellite in-orbit configuration is illustrated in Figures **1.3.1/1** and **1.3.1/2**.

The AVHRR/3 interfaces with the following PLM units :

- the NOAA Instrument Interface Unit **(NIU)** provides all command and control interfaces to the, **AVHRR/3,** i.e. **configuration** and mode switching (commands), command verification, housekeeping telemetry acquisition, and clock and time management. The NIU also acquires the measurement data from the instrument.
- the Power Conversion Unit **(PCU)** provides the **AVHRR/3** with'the regulated buses.
- the Thermal Control Unit **(TCU)** provides heater **power** supply and acquires the corresponding thermistor outputs.



WARNING : MAY BE SUBJECT TO CHANGE

Figure 1.3.1/1 : METOP Satellite Overall Configuration (For Information Only)

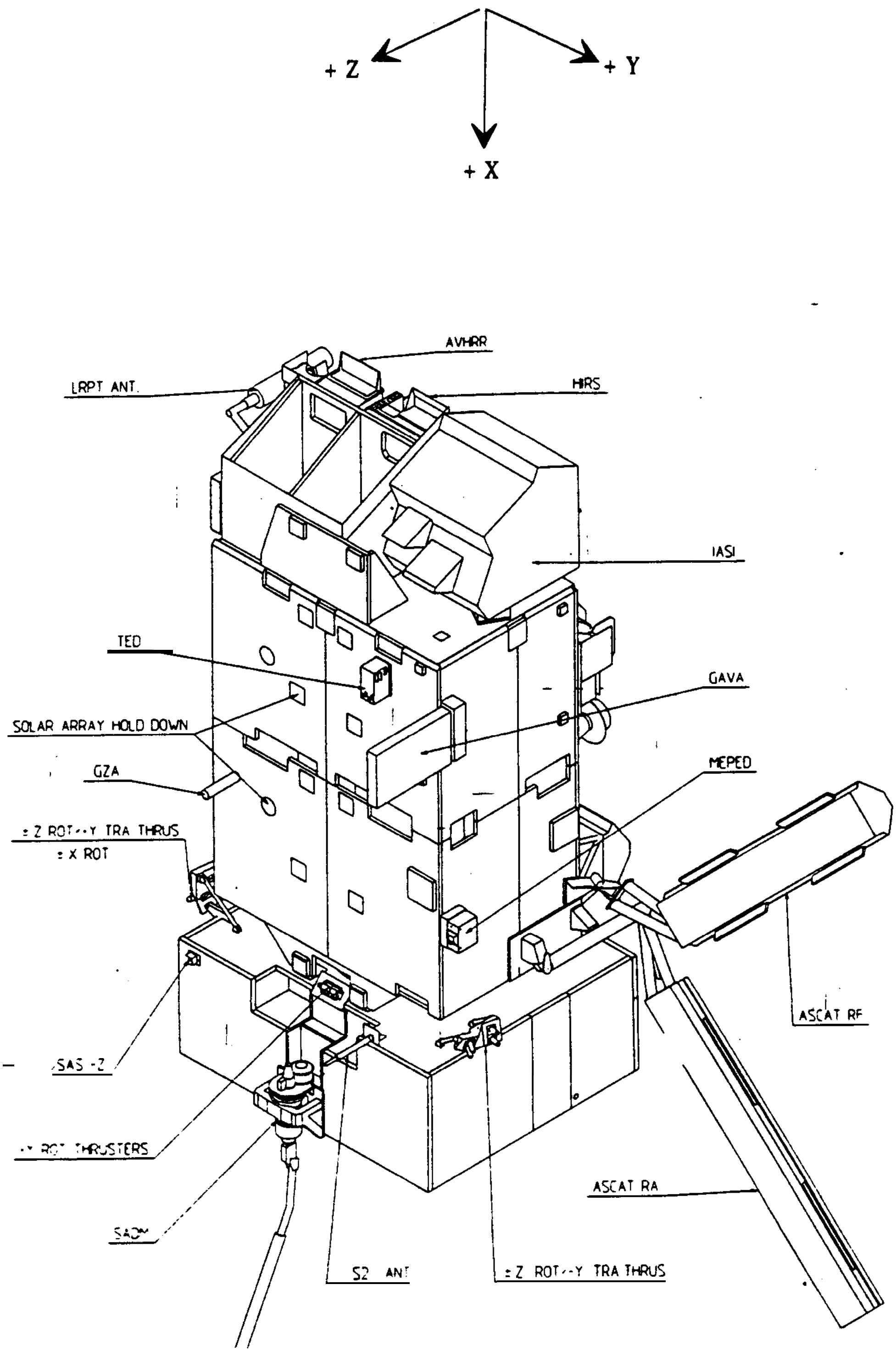


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Figure 1.3.1/2 : Back View of the Satellite (For Information Only)

13.2. METOP Reference Frames

13.2.1. Satellite Reference Frame

The METOP satellite coordinate system is defined as follows (Spacecraft Absolute Reference Frame $(O, X_s, Y_s, Z_s)\ F_s$) :

0 is located within the spacecraft to launcher separation plane, at the centre of the attachment ring,

The Xs-axis is perpendicular to this separation plane and oriented from the spacecraft towards the launch vehicle,

The Zs-axis is the normal-out of the surface that carries the stowed solar array,

The Y s-axis completes the right-handed orthogonal reference frame.

This reference is illustrated in Figure 1.3.2/1..

During normal payload operations, the (+X)-axis will be closely aligned to the orbit positive normal direction, the (-Y)-axis will be closely aligned to the METOP velocity vector and the (-Z)-axis will be closely aligned to the local downward direction (nadir)[1].

1.3.i.2. Instrument Reference Frame

The following is a requirement for the definition of the instrument reference frame. The frame specific to the AVHRR/3 is defined in § 2.1.3.2.

The instrument shall have a right handed orthogonal coordinate reference system $(X_{AVHRR}, Y_{AVHRR}, Z_{AVHRR})\ F_{AVHRR}$ and it shall be defined such that :

- the origin shall be physically located on an accessible, identifiable instrument exterior feature (e.g. the centre of one mounting hole, at the instrument baseplate level)
- the axes being ideally aligned with the X_S, Y_S, Z_S spacecraft axes, e.g. for instruments mounted on the platform nadir side, the datum plane which shall contain the X_{AVHRR}, Y_{AVHRR} axes, is the plane containing the unit mounting lugs, and the Z_{AVHRR} **axis** is perpendicular to this datum plane in the direction from the unit to the datum plane.

These axes shall be referred to on all drawings and any finite element description.

[1] For information, the correspondence between the METOP reference axes and TIROS reference axes is :
Xs METOP = Z TIROS Ys METOP = Y TIROS **Zs METOP = - X TIROS**

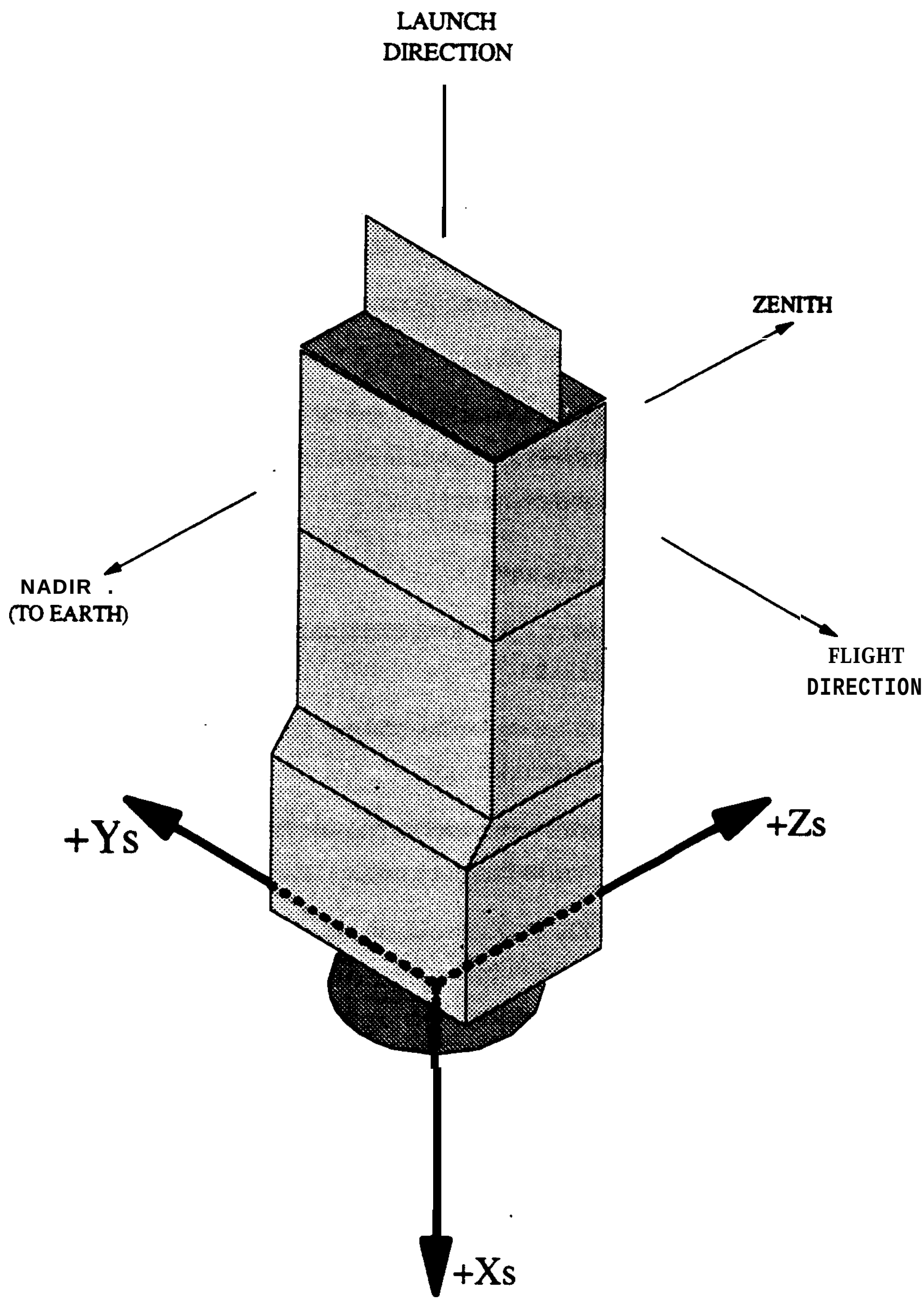


Figure 1.3.2/1 Satellite *Reference Frame*

1.3.3. Orbital Parameters

13.3.1. Reference Orbit

METOP will be placed into the following reference orbit :

-Type:	sun-synchronous
- Semi-major axis :	7197.939 km
- Repeat Cycle :	5 days (14 + 1/5 orbits per day)
- Local Solar Time :	09:30 AM. descending node

The maximum solar aspect angle for this orbit is 60.5 deg. (the solar aspect angle is defined as the angle between the satellite to Sun line and the normal to the orbital plane).

1.3.3.2. Drift Orbit

For **METOP-1,** the previous orbit will be reached after a **6-month (TBC_{MET})** drifting phase (dual launch), from an initial polar orbit (close to the Sun-synchronous one) with a local solar time around 10:00 A.M. descending node.

The maximum solar aspect angle for this orbit is 67.0 deg. (the solar aspect angle is defined as the angle between the satellite to Sun line and the normal to the orbital plane).

MRTOP-2 will be directly launched into the reference orbit.

1.3.4. Satellite Mission Phases and Operations

1.3.4.1. Mission Phases

During its lifetime, the satellite is operated through the following mission phases :

- Launch Phase

  The proper launch phase begins at the instant of switching the power subsystem to on-board batteries before lift-off and ends at satellite/launch vehicle separation.

- Acquisition Phase

  This phase starts at the end of the launch phase and ends once the satellite has acquired its operational attitude and orbit with its appendages deployed An initial acquisition sequence leading to a system secured state, is followed by a final acquisition period.

- Commissioning Phase

  This phase starts once the attitude and orbit have been acquired and covers the time that subsystems and instruments are checked out. It ends when the payload is operational for the nominal orbit.

For METOP-1, it starts when the satellite **is still drifting to achieve the nominal local solar time** of 09:30.

- Routine / Operational Phase

This phase starts at the end of the commissioning phase and covers the time when the instruments are operational and the times when orbit maintenance manoeuvres are performed.

1.3.4.2. Satellite Operational Modes

This section describes the satellite operational modes and the corresponding pointing performances. Note : the AVHRR/3 provides no scan compensation for satellite pointing errors, scanner jitter may temporarily worsen during rapid changes in spacecraft attitude.

1.3.4.2.1. Nominal Operational Mode

The nominal operational mode for METOP SVM is the Yaw Steering Mode (YSM[2]). During this mode, the PLM is in its Operable Mode : the instruments can be nominally operated through their measurement, heater. calibration... modes, and measurement data are transmitted to the ground

The characteristics of the satellite nominal operational mode are the following :

Nominal Mode (YSM)			
Commanded Pointing	-Zs	Pointing towards nadir	
	-Ys	Pointing towards the velocity	
Pointing Performances (According to ESA Summation Rules)			
Absolute Pointing Error AVHRR/3 Line of Sight (TBC_{MET})	xaxis f0.17 deg.	Yaxis ± 0.17 deg.	Z axis ± 0.22 deg.
Pointing Knowledge All Instrument Interface Reference Frames	X axis cko.17 deg.	Yaxis f0.17 deg.	.zaxis ± 0.22 deg.
Absolute Rate Error (Max, 0-4 Hz)	X, Y, Z axes ± 0.005 deg./s TBC_{MET}		

1.3.4.2.2. Orbit Control Modes

The previous performances are not guaranteed during large amplitude orbit control manoeuvres for altitude maintenance or inclination maintenance. Those are performed in SVM Orbit Control Mode (OCM) or Fine Control Mode (FCM).

During those modes, the PLM is still operable and the instrument nominal operations are not stopped, even if the generated measurement data may be corrupted. This is not true for the initial orbit

2 **During the Yaw Steering Mode (YSM), the satellite Z axis (yaw) is steered according to sinusoidal function over the orbit with an amplitude of about 4 deg.**

corrections, for which the PLM and the instrument status are in LEOP / Off Modes (see specific provision for **AVHRR/3** in § 1.4.2).

Altitude Maintenance

For altitude maintenance during the routine phase (in-plane manoeuvres), the commanded attitude is similar to the one in the nominal operating modes (**YSM** or local orbital reference frame), but **with** different pointing performances :

Orbit Control Mode : Altitude Maintenance		
Commanded Pointing	**-Zs**	**Pointing towards nadir**
	-Ys	Pointing towards the velocity
Pointing Performances		
Absolute Pointing Error **All Instrument Interface** Reference Frames	**X, Y, Z axes** **± 2 deg. TBC_{MET}**	

Inclination Maintenance

For inclination maintenance during the routine phase (out-of-plane manoeuvres), the satellite body is rotated by 90 deg. ± 20 deg. around the yaw axis (Z-axis), and by ± 20 deg. around the X-axis (local orbital reference frame), and a thrust normal to the orbit plane is performed. **The** rotation direction can be both clockwise and anti-clockwise and occurs around a node of the orbit.

The overall **manoeuvre** (rotation, thrust and back rotation) is performed during the eclipse phase of the orbit_

During these **manoeuvres**, the nominal mode is stopped for typ. 4 orbits, but the duration. from the beginning of first rotation to the end of back rotation is less than 1800 sec.

The pointing **performances** are then :

Orbit Control Mode : Inclination Maintenance Pointing Performances	
Absolute Pointing Error **All Instrument Interface** Reference Frames	**X, Y, Z axes** ± 2 dee. **TBC_{MFT}**

1.3.4.2.3. Acquisition Modes

The acquisition modes encompass all actions leading to a stabilized Earth attitude, including deployment of all major appendages.

The corresponding SVM modes are the Rate Reduction Mode (RRM), the Coarse Acquisition Mode (CAM), the Fine Acquisition Modes (**FAM1**, FAM2 and FAM3) and the Fine Pointing Mode (FPM).

During these modes, the PLM is in the Lift-Off Mode and then LEOP Mode. ~~In general, all instruments are switched off.~~ to

Once the satellite attitude is stabilized, the pointing performances are the following (local orbital reference frame) :

Acquisition Modes			
Commanded Pointing	**-Zs**	Pointing towards nadir	
	-Ys	Pointing towards the velocity	
Pointing Performances			
Absolute Pointing Error **All Instrument Interface** Reference Frames	**X axis** **± 5.0 deg** **TBC_{MET}**	**Yaxis** **± 5.0** deg. **TBC_{MET}**	**zaxis** **± 7.5 deg.** **TBC_{MET}**
Absolute Rate Error (Max, 0-4 I-W	**X, Y, Z axes** ± 0.05 deg /s TBC_{MET}		

Note : The mode sequence up to a stabilized satellite attitude may last up to 3500 sec.

1.3.4.2.4. Contingency Cases

In the event of detection of a satellite failure, several back up modes exist at PLM and / or SVM levels.

PLM **Failure Cases**

For failure at PLM level only, the corresponding PLM modes are the PLM Stand-By Mode, the PLM to OFF MODE Fix Mode and the PLM Safe Mode, depending on the failure. All instruments are switched off (see specific provision for **AVHRR/3** in § 1.4.2).

The SVM is not affected and the nominal attitude is maintained (see § 1.3.4.2.1.)

SVM Failure Cases

For failure at SVM level, the PLM is forced to PLM Stand-By Mode, PLM Fix Mode to OFF MODE or PLM Safe Mode, depending on the failure, and all instruments are switched ~~off~~ (see specific provision for **AVHRR/3** in § 1.4.2).

The SVM enters several modes that lead to a stabilized Earth pointing attitude. From an operational point of view, those modes are similar to the very first attitude acquisition that follows the separation from the launch vehicle, but with deployed appendages..

Once the satellite attitude is stabilized the pointing performances are the same as those described in § 1.3.4.2.3. with similar delay performances up to a stabilized satellite attitude.

1.3.4.2.5. Safe Mode (Sun Pointing)

In addition to the previous back-up modes, an ultimate safety level is implemented on **METOP.** This so-called Safe Mode performs the minimal functions for satellite survival by maintaining a Sun-pointed attitude. During the Safe Mode, the PLM is in the PLM Safe Mode and all instruments are switched off (see specific provision for **AVHRR/3** in § 1.4.2).

The characteristics of such a mode are :

Safe Mode			
Commanded Pointing	**+Zs** **Pointing** towards the Sun		
	The attitude is not controlled but **remains** within the limits specified below		
Pointing Performances			
Absolute **Pointing Error**	sun-lit phases'	xaxis' ± 15 deg.	**Y axis** **± 15 deg.**
All Instrument Interface Reference **Frames**	shadowedphases	**X axis** ± 20 deg.	**Y axis** ± 20 deg.
	Delay between eclipse and Sun-lit performances : 500 **s**		
Absolute Rate Error **(Max, 0-4 Hz)**	**The** rate about any axis is controlled **between** 0 and **±0.1** deg./s. **TBC**$_{\mathbf{MET}}$ There is no commanded **spin.**[3]		

The transients to reach this final attitude may last up to one orbit. Transitions to this final attitude are undetermined.

3 **As a consequence. the (-Xs) side of the satellite, that nominally faces the cold space, may continuously face the Earth albedo during the safe mode.**

1.4. INSTRUMENT OPERATIONAL MODES

1.4.1. Operational Constraints

To assure proper in-orbit operations of the AVHRR/3, certain practices are to be observed during the mission phases (see § 1.3.4.1.). These are:

a) The instrument is to be launched, in the Off Mode (see § 1.4.2.1.), with the scan motor running in the high power mode, in order to prevent damage to the scanner bearings. This statement is also valid for vibration testing.

b) The AVHRR/3 can be operated, within the constraints hereafter defined, at any time during the drift phase of the orbit. .

c) The first operational step for the AVHRR/3 is the switch-on of the radiant cooler heaters. The heaters shall remain on with the cooler door closed for a minimum of two weeks to allow the instrument to be outgassed.

d) Channels 1, 2 and 3A may be activated at any time, but Channels 3B, 4 and 5 shall remain off until outgassing is completed and the detectors have reached their operating temperature.

e) Upon completion of the outgassing period, the radiator heater is turned off.

f) After completion of the initial outgassing period, one shall proceed with the opening of the radiant cooler door. This door is opened by a satellite generated command (initiated from ground) that applies power within the instrument to the deployment mechanism This command shall be enabled for at least 2 sec. but not more than 5 sec. to avoid overheating of the deployment mechanism. The verification that the door is opened is performed by the ground system (analysis of the AVHRW3 Analog Telemetry).

g) Approximately 18 hours after the cooler door is opened,. channels 3B, 4 and 5 may be activated. AVHRR/3 generated radiometric data are not reliable before total stabilization of the temperature i.e. before a 48-hour period after the channels 3B, 4 and 5 have been enabled.

h) Once the cooler door is opened all orbit control manoeuvres (inclination manoeuvres) shall be performed in eclipse, to guarantee the instrument mission performances.

i) The nominal operating mode for AVHRR/3 is the Measurement Mode. During this mode, the only operational command ~~requirement~~ for the satellite is to provide the 3A / 3B channel selection command to the AVHRR/3 (See § 1.4.2.3.).

j) Because of the potential that the scan motor may not re-start, instrument operations shah be structured to avoid the Inert Mode. All actions leading to AVHRR/3 Inert Mode (see § 1.4.2.5) are considered as critical.

k) In case of PLM failure, the clock and power (10 & 28 V) may not be available at the instrument interfaces for a maximum duration of 36 hours. Upon interruption of the clock to 'the AVHRR, the scan motor will stop, even if power remains supplied.

1) The measurement data acquisition of Digital A Data from **AVHRR/3** may be corrupted in case of spacecraft failure (i.e. Data Enable and Clock interrupted). In this case, the instrument shall be **reset** by ground command i.e. by powering down to Off Mode and following powering up the instrument to Measurement Mode.

Note : **The** motor has two power modes of operation but is operated in-orbit only in the high-power mode.

1.4.2. Instrument Mode Overview

1.4.2.1. **AVHRR/3** Off Mode

During the **AVHRR/3** Off Mode, the **AVHRR/3** is unpowered except for the scan motor and the required power buses **(+28** V Main Bus and **+28** V Motor Bus), and the satellite provides the **AVHRR/3** with a 1 MHz clock for the operation of the motor and the related + 10 V Interface Bus. No other service (telemetry, monitoring...) will be performed.

This Off Mode **for AVHRR/3** is used **:**

- during the **METOP** launch and **acquisition** phases, with the cooler door **in** the closed position.
- during the **METOP** contingency cases, **with** the cooler door either in the closed or open position (see **§** 1.3.4.2.4).
- during the **METOP** safe mode, **with** the cooler door either in the closed or open position (see **§** 1.3.4.2.5.).

1.4.2.2. **AVHRR/3** Heater Mode

This mode is used for the decomamination / outgassing of the instrument.

1.4.2.2.1. Initial Heater Mode

After launch the radiant cooler heat er shall be turned on and remain on with the cooler door **closed,** to allow the instrument to be outgassed.

The visible channels 1, 2 and 3A can be enabled at any time during the initial decontamination / outgassing heater mode.

This configuration, with the scanner motor running, the decontamination heater on and the visible channels on, defines the **AVHRR/3** Heater Mode.

There is no time constraint for ~~triggering~~ commanding this first Heater Mode.

Duration for the initial decontamination / outgassing : **see §** 1.4.1 **.c.**

After the end of the initial heater mode, the cooler door is opened : **see § 1.4.1** .f.

1.4.2.2.2. Subsequent Heater Modes

Open-door decontaminations are done on demand. They last approximately 10 days.

1.4.2.3. AVHRR/3 Measurement Mode

This mode is defined as the normal operating mode of the AVHRR/3, with the instrument generating measurement data in both visible and infra-red channels.

The AVHRR/3 Measurement Mode shall not be triggered if the instrument radiant cooler door is closed.

It is characterized by the following command :

Channel Selection

In the measurement mode, the instrument requires a switching command, in order to use the channel 3A or the channel 3B.

This switching command is a stored ground command. It is nominally sent twice per orbit to AVHRR/3 to enable channel 3A over the day-lit Earth and channel 3B over the dark Earth. It occurs coincidentally with the crossing of the sub-satellite point day / night terminator.

This channel selection is done as described in § 3.2.6.2.

1.4.2.4. AVHRR/3 Voltage Calibration Mode

The Voltage Calibration Mode is not normally used during in-orbit mission operations, but is available as a trouble-shooting aid

1.4.2.5. AVHRR/3 Inert Mode

This mode is considered as a contingency mode for the instrument.

totally

In the Inert Mode, the instrument is off, i.e. no power supply (but survival thermal control).

The Inert Mode can only be triggered by a ground command. Note : the AVHRW3 Inert Mode can also be triggered as a result of on-board failure (e.g. converter, LCL...).

This mode is used for emergency shutdown. The instrument can be turned off in any sequence.

1.43. Cross Reference Between Instrument and PLM Modes

Phases	PLM	AVHRR/3	Comments
Launch and Acquisition Phases	Lift-Off Mode LEOP Mode	Off Mode	Stowed cooler door
Pre-Operational Phase	Stand-By	Off Mode	Stowed cooler door
Operational Phase	Operable	Off Mode Heater Mode Measurement Mode Voltage Cal. Mode (Inert Mode)	The door is opened after completion of the first Heater Mode
Orbit Control Manoeuvres	Operable	Any	
	Stand-By	Off Mode	
Contingency Cases	Stand-By Fix Safe	Off Mode (Inert Mode)	

1.5. INSTRUMENT LAUNCH AND IN-ORBIT OPERATIONS

The AVHRR/3 operational sequences, as used on METOP, are illustrated in Figure 1.511.

1.5.1. General

Instrument operational constraints are presented in § 1.4.1 . .1.

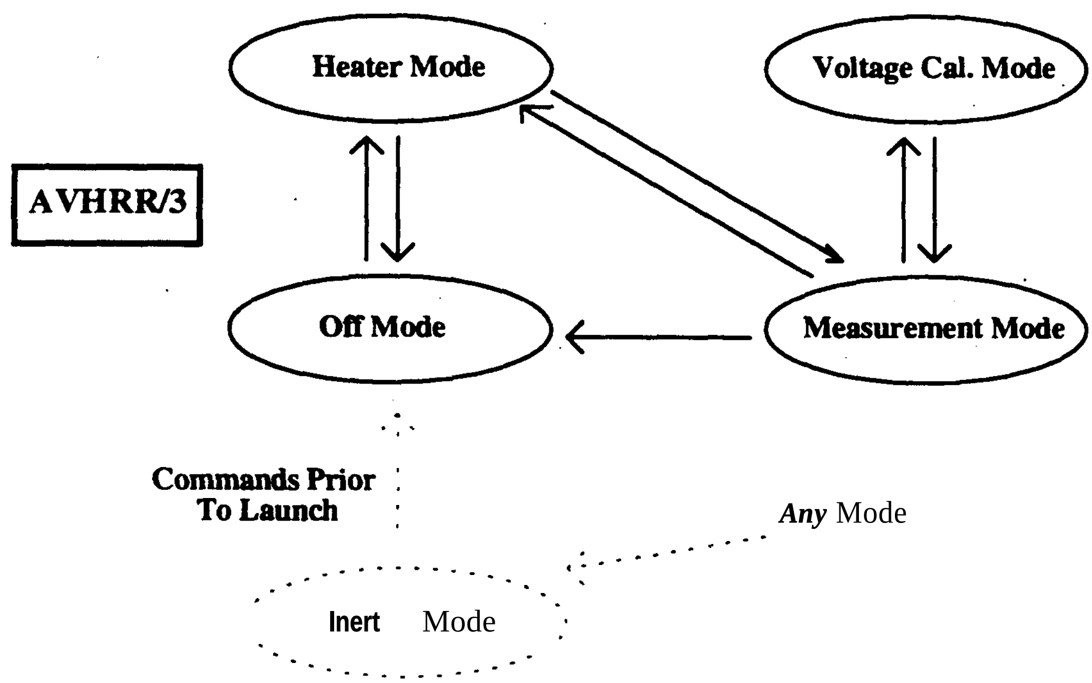
commands

The *minimum time* between two consecutive is specified in § 3.22.

AVHRR/3 telecommands are described in § 3.2.2

The acknowledgement of the commands by the instrument is done with Digital B telemetry points as described in § 3.2.3. and § 3.2.4. When no Digital B telemetry point is available, the acknowledgement is done with the instrument Analog Housekeeping telemetry on the ground.

Instrument operations during tests are described in § 5.3.5.



Note : Ch. 1, 2& 3A can be enabled during Heater Mode

Figure 1.5/1 : AVHRR/3 Mode Operation Sequence Used on METOP

1.5.2. Instrument Sequences to AVHRR/3 Off Mode

15.2.1. Nominal Sequence to Off Mode

The instrument switch-off sequence from any mode except Inert Mode, into Off Mode (with motors running) shall be as following :

1) Voltage Calibrate OFF
2) Telemetry Locked ON
3) Cooler Heater OFF
4) Patch Control OFF
5) Channel 1 DISABLE
6) Channel 2 DISABLE
7) Channel 3A DISABLE
8) Channel 3B DISABLE
9) Channel 4 DISABLE
10) Channel 5 DISABLE
11) Electronics/Telemetry OFF

1.5.2.2. Sequence from Inert Mode to Off Mode

AVHRR/3 Instrument **Initialization**

1) Patch Control OFF
2) Channel 1 DISABLE
3) Channel 2 DISABLE
4) Channel 3A DISABLE
5) Channel 3B DISABLE
6) Channel 4 DISABLE
7) Channel 5 DISABLE
8) Cooler Heat OFF
9) Earth Shield Disable
10) Voltage Calibrate OFF
11) Electronics/Telemetry OFF
12) Telemetry NOT Locked On
13) Scan Motor / Telemetry OFF

To **AVHRR/3** Off Mode

14) Scan Motor/Telemetry ON
15) Scan Motor High Mode
16) Telemetry Locked ON

The previous command sequences shall be executed prior to the launch.

152.3. Emergency Sequence to AVHRR/3 Off Made

In case of emergency (including depointing), the NIU shall **issue the following command sequence** to the instrument, which will switch down the **AVHRR/3 to Off Mode :**

1) Electronics/Telemetry OFF
2) Patch Control OFF
3) Cooler Heater OFF
4) Earth Shield DISABLE

This emergency switch&f sequence shall be completed within **50 s.**

To keep the motor running, the PCU (28 V) shall not interrupt the power supply to the instrument and the 10 V Interface Bus provided by the NIU will not be switched off. **The** clock shall not be removed from the interface.

Note : Handling of measurement data may be switched-off immediately after emergency signal reception by the NIU.

153. Instrument Sequences To AVHRR/3 Heater Mode

153.1. Sequence From Off Made to Heater Mode

This sequence is also valid for the initial Heater Mode.

1) Channel 3B DISABLE
2) Channel 4 DISABLE
3) Channel 5 DISABLE
4) Telemetry Locked ON (redundant)
5) Cooler Heater ON
6) Electronics/Telemetry ON
7) Channel 1 ENABLE
8) Channel 2 ENABLE
9) Channel 3A Select
10) Channel **3A ENABLE**

Note : During the **outgas** mode, channels **3B,** 4 and 5 are disabled to limit the temperature rise in the detector chips (see § 1.4.1).

1.5.3.2. Sequence From Measurement Mode to Heater Mode

1) Patch Control OFF
2) Channel 3A Select
3) Channel 3B DISABLE
4) Channel4 DISABLE

5) Channel 5 DISABLE
6) Telemetry Locked ON (redundant)
7) Cooler Heater ON

1.5.4. Instrument Sequence to AVHRR/3 Measurement Mode

15.4.1. Pre-Sequence : *Opening* of the Cooler Door After Initial Heater Mode

After the initial Heater Mode, the cooler door shall be opened with the following sequence :

1) Cooler Heater OFF
2) Earth Shield DEPLOY
3) Earth Shield DISABLE

The following constraints shall be taken into account (see § 1.4.1) :

a) The cryogenic radiator outgas heaters shall be turned off before the cryogenic radiator door is opened : see § 1.4.1-e

b) Time constraint between Earth Shield DEPLOY and Earth Shield DISABLE : see § 1.4.1 -f

1.5.4.2. Nominal Sequence to Measurement Mode

This sequence is only valid from Heater Mode to Measurement Mode.

1) Cooler Heater OFF
2) Patch Control ON
3) Wait till patch temperature stabilizes at 105 K.
4) Channel 3B ENABLE
5) Channel 4 ENABLE
6) Channel 5 ENABLE
7) Channel 3B Select (toggled with *Channel 3A* Select for day / night operation)

There is no time constraint to enter Measurement Mode from Heater Mode (once the decontamination is completed). The PATCH TEMPERATURE CONTROL may be turned ON at any time during cool down.

1.5.5. Instrument Sequence To and From AVHRR/3 Voltage Calibration Mode

The following sequence is only valid from the Measurement Mode to Calibration Mode :

1) Voltage Calibrate ON

The following sequence is only valid from the Calibration Mode to Measurement Mode:

1) Voltage Calibrate OFF

There is no time constraint to enter Voltage Calibration Mode from Measurement Mode.

There is no time constraint to enter Measurement Mode from Voltage Calibration Mode.

15.6. Contingency Operations : Instrument Sequences to AVHRR/3 Inert Mode

The following switch-off sequence from any mode to Inert Mode is executed after ground confirmation.

1.5.6.1. Nominal Sequence to Inert Mode

The instrument switch-off sequence from any mode into Inert Mode shall be as following :

1) Telemetry Locked ON
2) Cooler Heater OFF
3) Patch Control OFF
4) Channel 1 DISABLE
5) Chaunel2 DISABLE
6) Channel 3A DISABLE
7) Channel 3B DISABLE
8) Channel 4 DISABLE
9) Channel 5 DISABLE
10) Electronics/Telemetry OFF
11) Scan Motor / Telemetry OFF
12) Telemetry Not Locked ON
13) Earth Shield DISABLE
14) Voltage Calibrate OFF

1.5.6.2. Emergency Sequence to Inert Mode

The sequence is limited to :

1) Electronics/Telemetry OFF
2) Scan Motor / Telemetry OFF
3) Telemetry Not Locked ON

or

Removal of the 28V and 10V power buses

This emergency switch&f sequence shall be completed within 50 s.

2. MECHANICAL AND THERMAL INTERFACE DESCRIPTION

BLANK

2.1. GENERAL

2.1.1. Interface Definition

The interface definition for the instrument is the following :

Instrument	Satellite
Mechanical	
Instrument unit Alignment device in the form of two orthogonal mirrors permanently mounted on the instrument and aligned by the Instrument Supplier All instrument non-flight covers (including aperture cover, radiator dust cover and connector covers)	Attachment bolts Head bold washers Adjustment shims Ground strap
Thermal	
Unit thermal control hardware : - Blankets, - Operational mode internal heaters, - Operational mode internal temp. sensors. Mounting of the baseplate operational (main and redundant) and survival heaters to baseplate prior to painting with pig-tails for connection to the spacecraft harness.	Thermal washers 1 & 2 Additional thermal isolation stand-off (TBD_{MET}) Baseplate radiator shield : to provide a view to space for the baseplate radiator and shielding from direct solar radiation onto the deployed radiant cooler door Additional Sun shields : to ensure that there is no solar illumination of the deployed radiant cooler door. Thermal blankets attached to the METOP structure, Main and redundant operational METOP specific heaters and related thermistor sensors for the control of the temperature at the instrument baseplate, as defined in this ICD, Survival thermostat-controlled heaters and related thermostats for the control of the temperature at the instrument baseplate, as defined in this ICD.

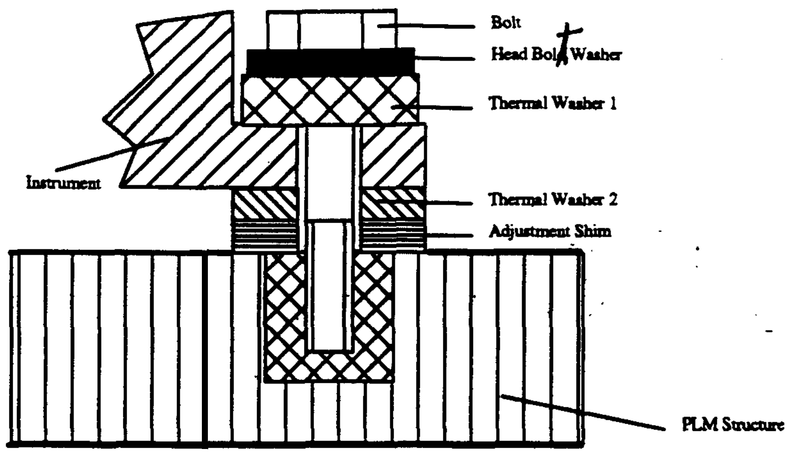


Figure 2.1.1/1 : Definition of Attachment Hardware (Generic Schematics)

2.1.2. Module / Unit Identification

The Part Number and Identification Code of the **AVHRR/3** instrument are :

1)	'Equipment Name :	Advanced Very High Resolution Radiometer
2)	Purchase Order Or Contract Number :	NAS5-30384
3)	Manufacturer Name :	ITT Industries Aerospace / Communications Division
4)	Part No :	EM : N/A FM1 : 815732962 [1] FM2 : 815732964
5)	ID Code :	Cage Code 3 1550
6)	METOP ID Code	N/A

'The location of .the labels giving these Part Numbers and Identification Codes are defined in the Mechanical Interface Control Drawing (See § 2.1.4.).

[1] Part number given assumes that the FM1 will be A304 and the FM2 will be A306. NASA / NOAA may deliver any ~~identical~~ unit to METOP.
equivalent

2.13. Reference Frames

2.13.1. Satellite Reference Frame

see § 1.3.2.1.

2.13.2. Instrument Reference Frame

The reference point for all mechanical and thermal data is the centre of the attachment point number 1, as shown in the Interface Control Drawings (at the interface to the PLM **structure, see § 2.1.4).**

The **AVHRR/3** Instrument **Interface** Reference Frame, $\mathbf{F_{AVHRR}}$, with the origin being at the reference point, is as **defined** in the Mechanical Interface Control Drawing (see **§** 2.1.4.). **The** directions of the $\mathbf{F_{AVHRR}}$ axes are the same as the **Spacecraft** Reference Frame Fs.

2.1.4. Interface Drawings

2.1.4.1. Mechanical Interface Drawings

The AVHRR/3 instrument configuration and mechanical **interfaces** are illustrated **in** the following interface drawings :

- **AVHRR/3** Instrument Deployed Interfaces, Ref. **MMS-106490-S-DD-1/4-03**
- **AVHRR/3** Instrument Stowed Interfaces, Ref. **MMS-106490-S-DD-3/4-03**
- **AVHRR/3** Instrument Connector Panel, Ref. **MMS-106490-S-DD-4/4-02**
- **AVHRR/3** Instrument Alignment Mirrors, Ref. **110217-X-DD-1/2-01**
- **AVHRR/3** Instrument Accessibility, Ref. MMS-110225G-DD-l/l-01

2.1.4.2. Thermal Interface Drawing

The AVHRR/3 instrument thermal interfaces are illustrated in the following interface &awing :

- **AVHRR/3 Thermal** Interfaces. Ref. **MMS-106493-X-DD-1/1-03**

2.1.4.3. **Field** of View **Interface Drawing**

The AVHRR/3 instrument field of view is illustrated in the following interface &awing :

- **AVHRR/3** Instrument Field of View, Ref. **MMS-106490-S-DD-2/4-03**

2.2. MECHANICAL INTERFACE DESCRIPTION

2.2.1. Physical Envelope

AVHRW3 is fully integrated into a single instrument unit.

The external unit dimensions in both launch and in-orbit modes, including thermal blankets, studs, mounting lug and connector envelopes, shall be to a tolerance of ±1 mm, These are:

AVHRR/3 Configuration	Y axis (Velocity)	X axis	Z axis (Nadir)
Stowed Envelope	814.3 mm	482.1 mm	301.54 mm
Deployed configuration (Cooler Door Open)	814.3 mm	636.5 mm	301.54 mm

to be checked wrt. sunshield and 383.45 dimension in draw. p4

The overall dimensions are defined without thermal stand-off, which are METOP specific, and without the connector saver.

2.2.2. Field of View Definition

The accommodation on METOP provides AVHRR/3 with the following unobstructed Field of View (FoV, see also interface drawing § 2.1.4).

The AVHRR/3 boresight is defined as the nadir direction. The instrument field of view definition is :

- vertex: the origin of the field of view is quoted on the interface drawing (§ 2.1.4.).

- spacecraft provision :

- Cross-track scan plane : from 75 deg. anti-Sunwards to 58 deg. Sunwards.

  This is the general envelope for :

  5.0 deg. margin + 7.5 deg. anti-Sun calibration + 62.5 deg. anti-Sun-wards
  55.5 deg. Sunwards + 2.5 deg. margin

- Along-track plane : ± 2.5 deg.

The requirements for the instrument thermal radiators and the radiant cooler are specified in the Thermal Interface Description sections of this document (§ 2.3).

2.23. Mass Properties

The mass properties of the AVHRR/3 instrument are given in the following table. The co-ordinate system used is the Instrument Interface Reference Frame, F_{AVHRR}.

2.23.1. Mass and Centre of Mass Location

The AVHRR/3 centre of gravity location has been measured without the attachment bolts / washers or thermal stand-offs. Instrument to METOP PLM interface connectors and thermal blankets are included.

Module /Unit	Specified Mass	Centre of Mass Location With Respect to the Reference Point (± 0.5 mm)		
		X_{AVHRR} (Sun)	Y_{AVHRR} (Anti-velocity)	Z_{AVHRR} (Zenith)
AVHRR/3 stowed	35 kg	+ 129.84 mm	+ 386.82 mm	- 125.04 mm
AVHRR/3 Deployed	35 kg	+ 128.57 mm	+ 385.57 mm	-126.29 mm

AVHRR/3 Mass Properties

The AVHRR/3 instrument shall not exceed the above specified mass for the METOP mission.

The AVHRR/3 mass shall be measured at ± 0.5 %.

The AVHRR/3 basic (best estimate) mass is : 34.0 kg (for information only).

2.2.3.2. Moments of Inertia

The AVHRR/3 moments of inertia about the centre of mass of the instrument are as follows :

Module /Unit	Moments of Inertia (kg.m²)					
	I_{XX}	I_{YY}	I_{ZZ}	I_{XY}	I_{XZ}	I_{YZ}
AVHRR/3 Stowed	1.737	0.467	1.840	-0.029	0.018	0.180
AVHRR/3 Deployed	1.740	0.479	1.850	-0.026	0.012	0.183

AVHRR/3 Moments of Inertia

Note : The moments of inertia are defined as follows :

$$\begin{bmatrix} I_{xx} & -I_{xy} & -I_{xz} \\ -I_{xy} & I_{yy} & -I_{yz} \\ -I_{xz} & -I_{yz} & I_{zz} \end{bmatrix} \quad \text{with :} \quad \begin{aligned} I_{xx} &= \int (y^2+z^2)dm \\ I_{yy} &= \int (x^2+z^2)dm \\ I_{zz} &= \int (x^2+y^2)dm \end{aligned} \quad \text{and} \quad \begin{aligned} I_{xy} &= \int xydm \\ I_{xz} &= \int xzdm \\ I_{yz} &= \int yzdm \end{aligned}$$

23.4. Instrument Mounting Attachments

2.2.4.1. Mounting Description

The AVHRR/3 is mounted using the satellite-supplied thermal inserts and bolts through the instrument mounting feet. Where required METOP will provide additional thermal stand-offs.

The following table describes the instrument mounting ha&are :

Module / Unit AVHRR/3	Bolt Size	Instr. Mounting Hole Diameter (mm) (+ 0.10 / -0.00)	Length (mm)	Torque - (Nm)	Quantity
Instrument Unit	**M5 (TBC_{MET})**	10.82	**TBD_{MET}**	**TBD_{MET}**	6
Alignment Pins	**N/A**	**N/A**	N/A	N / A	**N/A**

Tolerances are specified in the interface drawings (see § 2.1.4.).

2.2.4.2. Mounting Hde Position and Reference Point (Hole)

The definition of the mounting holes and the instrument **Reference** Point / Hole for **AVHRR/3** is given in the Mechanical Interface Control Drawing (see § 2.1.4.).

2.2.4.X Mounting Surface Characteristics

instrument Side	Surface Coplanarity	Within 0.127 mm
	Surface Roughness of Attachment Face	0.8 **μm rms**
	Total Area of the Mounting Surface	2932 **mm²**
METOP Side	**Surface Flatness**	LessthanO.l mmin **100 mm**
	Surface Roughness of Attachment Face	≤ 1.6 microns R.A
	Shimming Accuracy for Flatness	Within 0.0254 mm

2.2.4.4. Instrument Location

The mounting surface is on the **-Z** (nadir) face of the balcony structure of the satellite.

2.2.45. **Materials** at Interfaces

Instrument Side	**AVHRR/3** Baseplate	Aluminium alloy 606 1 **-T65** 1
	Mounting Area Finish	**Alodyne** 600
METOP Side	Balcony **Structure**	Aluminium skin with a honeycomb core
	Attachment Bolts and Washers	**Titanium** bolts with stainless steel **washers**
	Thermal isolation stand-off material	**TBD_{MET}**

2.2.4.6. Thermo-Elastic Interface

The thermo-elastic characteristics shah be defined in a reduced mechanical interface model as defined in § 2.2.8.5.

2.2.4.7. Grounding Provisions

Grounding to the spacecraft structure is achieved by a METOP provided grounding strap.

The location (TBD_{MET}) of the grounding point on the instrument are defined in the Mechanical Interface Control Drawing (see § 2.1.4.).

2.2.5. Accessibility

Accessibility to specific parts of the instrument shall be guaranteed when accommodated on METOP. The faces on which specific parts are accommodated are defined in the following :

AVHRR/3 *This table indicates the viewing direction from the instrument.*			
	. Item	Instrument Side	Access Required
1	Electrical connectors	+x	During AIT activities
2	Connector Savers	+x	During AIT activities
3	connector dust caps	+X	When the instrument is not in use.
4	Test connector cover	+x	During all AIT activities
5	Alignment Mirror 1	-Y	During AIT alignment activities
6	Alignment Mirror 2	-Z	During AIT alignment activities
7	Dust cover for the scan cavity	-Z	During all AIT activities, except TB/TV and vibration
8	Dust cover for radiant cooler	-X	During all AIT activities, except TB/TV and vibration
9	Contamination Witness Mirror	-Y	To be removed prior to launch and vibration testing.
10	Radiant Cooler Door	-x	During AIT activities requiring the doortobeopen.
11	Purging interface	None	

The detailed position of these items are indicated on the Mechanical Interface Control Drawings (§ 2.1.4.).

2.2.6. On-Ground Alignment

2.2.6.1. Alignment Method

The primary co-registration of AVHRR/3 is with respect to the satellite reference frame. The instrument provides no means of aligmnent ad... No mechanical means of adjustment for rotation is foreseen about any axis for initial ground registration. The instrument is accommodated accepting the X, Y and Z axis positions. Measurement of the alignment of AVHRR/3, with respect to the spacecraft reference axis, is by use of the instrument provided optical reference mirrors mounted on the instrument and is measured to an accuracy of ± 0.006 degrees. There is no co-alignment requirement for AVHRR/3. However it is the reference for the co-alignment of all other instruments where required.

The cross references between the instrument boresight axis and its optical alignment Surface and between the optical alignment smface and the instrument mounting surface are established at instrument level and reported in the Acceptance Data P&cage.

2.2.6.2. Alignment Hardware

The position of the instrument optical reference mirrors is given in the Mechanical Interface Control Drawing (§ 2.1.4).

AVHRR/3 Alignment Mirrors	
Description	Two orthogonal alignment surfaces
Alignment Mirrors	Satellite -Z and -Y sides
Surface Size (for each round surface)	> 500 mm²
Surface Characteristics	Polished flat to within λ/4 where λ = Sodium Yellow (632.8 nm)
Surface Orthogonality	The two alignment surfaces are approximately orthogonal, with a known angular displacement that will be documented in the Acceptance Data Package. The mirror angular measurement accuracy is ± 0.00573 deg. (0.1 milliradd)

Protection of the alignment surfaces for all periods when not in use : tape TBD.

These mirrors are not removable.

2.2.6.3. **Alignment** Tolerances for **Instrument** Interfaces

The following table gives the alignment tolerances of **AVHRR/3**:

METOP Axes (2 Sigma Values)		**X (Deg.)** TBC	**Y (Deg.)** TBC	**Z (Deg.)** TBC	Respon-sible
Absolute alignment tolerance ***between*** ***and***	 the instrument line of sight ***the optical*** alignment surface.	± 0.344 *	± 0.170 *	± 0.344 *	**AVHRR/3**
Change of alignment tolerance after environmental test between ***and***	 the instrument line of sight **the optical** alignment surface	± 0.0285	± 0.0285 *	± 0.0285	**AVHRR/3**
Absolute alignment tolerance between ***and***	 the instrument line of sight its mounting surface	± 0.300 *	± 0.300 *		**AVHRR/3**
Change of alignment tolerance after environmental test ***between*** ***and***	 the instrument line of sight its mounting surface	± 0.0285	± 0.0285 *		**AVHRR/3**
Absolute alignment tolerance ***between*** ***and***	 ***the*** instrument line of sight ***the* mounting** surface hole pattern.	-		± 0.400 *	**AVHRR/3**

* Budget inputs for **METOP** ~~(no value provided by NASA)~~.

2.2.7. Deployment Mechanisms and **Pyros**

2.2.7.1. Deployment Mechanisms

The door for the **AVHRR/3** radiant **cooler** is deployable :

Cooler Dour Deployment	
Sequence	Single event
Mechanism	**Spring** driven
Release	Solenoid release or manual release for testing
Reverse Operation	**Manual only**

2.2.7.2. **Pyros**

Not applicable for **AVHRR/3**.

2.2.8. Interface Structural Design

Flight Limits Loads are enveloping the loads, including launch, manufacturing, handling, tranqortation and ground testing (excluding qualification testing).

Qualification Limit Loads add a qualification factor (1.25 for METOP) on top of the Plight Limit Loads.

2j.8.1. AVHRR/3 Limit Loads

The AVHRR/3 is tested to the following limit loads applied at the instrument interface attachment points :

	Load Axis		
	X	Y	Z
Maximum Plight Limit Load	12.40 g	12.40 g	12.40 g
Qualification Limit Loads	*15.55 g*	*15.55 g*	*15.55 g*

2.2.8.2. METOP Induced Limit Loads

Preliminary analysis indicate the following maximum predicted limit loads applied to the AVHRR/3 during the METOP mission :

Maximum Plight Limit Load	21.6 g	Applied at unit centre of gravity in any spatial direction
Qualification Limit Loads	27.0 g	

Figure 2.2.8.2/1 : METOP Induced Loads for AVHRR/3

The-se levels will be revisited following future structural analysis and the METOP structural model test campaign.

2.2.83. *l-g* Interface Loads

The AVHRR/3 1 -g interface loads, calculated at each interface point (zero preload). with the instrument hard-mounted configuration are presented in the following table :

AVHRR/3 Hard Mounted Interface Loads Based on 1 g Applied in X			
Attachment Id.	**Shear Force (N)**	**Axial Force (N)**	**Moment (N.mm)**
1	-123.46	113.97	16013.84
2	-214.73	23.39	10158.29
3	-144.58	53.51	16278.87
4	-359.06	139.28	34457.29
5	-303.24	68.57	42806.73
6	-144.41	61.90	20779.98
Alignment Pin	N/A	N/A	N/A

AVHRR/3 Hard Mounted Interface Loads Based on 1 g Applied in Y			
Attachment Id.	**Shear Force (N)**	**Axial Force (N)**	**Moment (N.mm)**
1	-55.45	287.80	16892.62
2	-56.81	133.38	10275.80
3	104.43	100.44	15513.37
4	162.70	174.00	31730.18
5	-28.38	303.95	7429.53
6	-126.50	302.26	7590.49
Alignment Pin	N/A	N/A	N/A

AVHRR/3 Hard Mounted Interface Loads Based on 1 g Applied in Z			
Attachment Id.	**Shear Force (N)**	**Axial Force (N)**	**Moment (N.mm)**
1	-152.23	150.78	16958.49
2	-161.56	167.39	25105.10
3	-496.61	195.25	7982.68
4	508.86	246.39	19975.25
5	175.76	474.76	33705.10
6	125.78	191.71	2608.91
Alignment Pin	N/A	N/A	N/A

2.2.8.4. Structural Frequency Characteristics

2.2.8.4.1. Launch Configuration Frequency Characteristics

The following gives the dynamic frequency characteristics of the AVHRR/3 sensor unit in the launch configuration.

AVHRR/3 Sensor Unit - Launch Configuration							
Frequency	Mode	Effective Mass (kg)			Effective Inertia ($kg.m^2$)		
(Hz, ± TBD_{AVH} %)		Mx	My	Mz	Ix	Iy	Iz
61	1. Earthshield	0.309	0.001	0.000	0.000	0.000	0.001
72	2. Patch rigid hody longi.	0.001	0.217	0.004	0.002	0.000	0.005
75	3. Patch rigid body torsional	0.002	0.02 1	0.187	0.006	0.005	0.000
95	4. Radiator (Z-direction)	0.016	0.001	0.211	0.009	0.012	0.000
122	5. Instrument lateral sway (X-direction)	9.435	0.002	0.161	0.001	0.100	0.091

AVHRR/3 Eigen Frequencies and Associated Effective Masses and Inertiae for the Launch Configuration.

2.2.8.4.2. In-Orbit Configuration Frequency Characteristics

The following gives the dynamic frequency characteristics of the AVHRR/3 sensor unit in the deployed configuration.

AVHRR/3 Sensor Unit - In-Orbit Configuration							
Frequency	Mode	Effective Mass (kg)			Effective Inertia (kg&)		
(Hz, ± TBD_{AVH} %)		Mx	MY	Mz	Ix	Iy	Iz
1.6	1. Earth shield rigid hody rotation on pivot	0.002	0.000	0.174	0.003	0.014	0.000
54	2. Earth shield bending asymmetric	0.001	0.003	0.002	0.005	0.000	0.000
71	3. Earth shield symmetric bending	0.004	0.001	0.016	0.000	0.001	0.000
72	4. Patch rigid body longi.	0.001	0.216	0.005	0.001	0.000	0.005
76	5. Patch rigid body torsional	***0.002***	***0.026***	***0.143***	***0.005***	***0.004***	0.001
96	6. Radiator (Z-direction)	0.011	0.001	0.156	0.007	0.005	0.000
124	7. Instrument lateral sway (X-direction)	11.329	0.005	0.327	0.003	0.117	0.093

A VHRR/3 Eigen Frequencies and Associated Effective Masses and Inertiae for the In-Orbit Configuration.

2.2.8.5. **Structural Mathematical Models - Applicability for AVHRR/3**

The requirements for delivery and format of instrument structural mathematical models are provided in AD2. This section defines the applicability of deliverable mathematical models for AVHRR/3.

2.2.8.5.1. Full Static Model

Not applicable for AVHRR/3.

2.2.8.5.2. Reduced Dynamic Model - Launch Configuration

Not applicable for AVHRR/3.

2.2.8.5.3. Reduced Dynamic Model - Deployed (In-Orbit) Configuration

Required Model for AVHRR/3 : Yes.

2.2.8.5.4. Simplified Thermo-Elastic Model

Required Model for AVHRR/3 : Yes

2.3. THERMAL INTERFACE DESCRIPTION

23.1. Thermal Control Concept

The Instrument Supplier is responsible for the thermal design and the thermal analysis of the instrument within the METOP defined thermal interface constraints.

For the TIROS implementation, the AVHRR/3 supplies the following internal hardware :

- Internal motor housing heaters
- Internal baseplate heaters
- Internal baseplate Platinum Resistance Thermometer (PRT)

For the TIROS implementation, the heaters for the baseplate and the motor housing are connected in parallel and controlled by the baseplate thermistor. All connections of the active thermal control of the instrument are done through the J33 connector.

For the METOP implementation, the use of this hardware is as follows :

- the AVHRR/3 internal motor housing heaters are not used and no thermal control of the motor housing is performed by METOP.
- the AVHRR/3 internal baseplate heaters and intemal baseplate thermistor are not used (TBC_{MET}).
- the J33 connector is not used , Test cap will be provided (if needed)
- Instead, main and redundant operational METOP-specific heaters and related thermistor sensors for control of the instrument baseplate, and survival heaters are used for thermal control.

23.1.1 Thermal Control During Nominal Operations

The nominal operations correspond to the AVHRR/3 Measurement Mode, Decontamination Mode (= Heater Mode) and Voltage Calibration Mode.

The instrument thermal control concept during Measurement Mode and Voltage Calibration Mode can be summarized as follows :

a) The detector temperature is controlled by means of a radiant cooler to deep space.

b) The instrument unit temperature is controlled by passive design (blankets and small radiating surfaces).

c) The baseplate temperature is actively controlled by the spacecraft Thermal Control Unit (TCU). METOP specific heaters are externally mounted on the baseplate and METOP specific temperature sensors for the baseplate are used for the thermal control by the spacecraft TCU.

During Decontamination Mode, the instrument decontamination heater and thermistor are monitored under the responsibility of the AVHRR/3. The power is provided by the +28 V regulated bus and does not exceed the values allocated in § 3.4.2. These heater and thermistor do not require a specific interface with METOP.

23.1.2. Thermal Control During Non Nominal / Contingency Operations

2.3.1.2.1. General'

The non nominal / contingency modes correspond to the AVHRR/3 Off Mode and Inert Mode.

The baseplate temperature is controlled using thermostat-controlled heaters and -related temperature thermostats.

2.3.1.2.2. Transient Attitudes

When the scanner motor is running, exposure of the AVHRR/3 optical aperture to the Sun will not cause damage to the instrument. .

The radiant cooler can be exposed to full Sun light for a maximum period of 14 minutes. This assumes that the patch starts at its nominal control' temperature,* i.e. 105 deg. K (= Measurement Mode configuration).

2.3.1.2.3. METOP Orbit Control Modes

The AVHRR/3 is compatible with the METOP orbit control modes (See § 1.3.4.2.), provided the inclination manoeuvres are performed in eclipse.

2.3.1.2.4. METOP Safe Mode

The AVHRR/3 in the Off mode is compatible with the METOP safe mode as defined in § 1.3.4.2.

233. Instrument Thermal Requirements

2.3.2.1. Instrument Temperature Range

2.3.2.1.1. On-Orbit Temperature! Range

The following are the on-orbit temperature limits (for reference only. see **§ 2.3.2.2**):

Deg. C	Operational (Measurement Mode)		Non Operational(Other Modes)		switch-on
	Min.	Max.	Min.	Max.	Min.
Temperature	+10	+30	-5	+30	0
Ref. Point Location	Baseplate		Baseplate		Baseplate

2.3.2.1.2. Ground Testing Temperature limits

The following temperatures will not be exceeded during all ground tests :

Deg. C	Operational (Measurement Mode)		Non Operational (Other Modes)		Switch-On
	Min.	Max.	Min.	Max.	Min.
Temperature	+10	+30	-5	+30	0
Ref. Point Location	Baseplate		Baseplate		Baseplate

Under these extreme temperatures, the instrument may not meet its radiometric specification.

2.3.2.1.3. Ground Storage and Transportation Temperature Range

During ground storage, with the instrument installed on the PLM or satellite, and during transportation of the complete PLM or spacecraft, the temperatures of the instrument will be maintained in the range :

– 5 +30
~~-20 to + 50 deg~~. C

– 5 / +30

The instrument in its dedicated transport container will be exposed to ~~-20 / +50~~ deg. C. ~~If needed (TBC~~$_{AVH}$~~), cooling / heating beyond these limits within the unit transport container are under the responsibility~~ of the Instrument Supplier.

23.23. Temperatures at the Interface

The operating, nonoperating and switch-on temperatures for the **AVHRR/3** instrument at the instrument / satellite interface are defined hereafter.

Deg. C	Operational (Measurement Mode)		Non Operational (Other Modes)		Switch-On
	Min.	Max.	Min.	Max.	Min.
Temperature	+10	+30	-5	+30	- 0
Ref. Point Location	Baseplate		Baseplate		Baseplate

The Temperature Reference Point(s) on the instrument baseplate at which these temperatures apply is (are) defined in the Thermal Interface Drawing (TBD_{MET}).

There is no thermal gradient requirement 'across 'the baseplate. However thermal gradients shall be minimized by optimal positioning on the baseplate heaters.

Stability Requirements

There is a thermal stability requirement for the baseplate only during Measurement Mode

Within one orbit, the maximum allowable temperature variation of the baseplate shall be 3 deg. peak to peak. The long term mean temperature will fall within the defined operating temperature range.

2.3.2.3. **Radiative Requirements**

The following Sun shields are provided :

Instrument Level

A Sun shield is included in the **AVHRR/3** design to protect direct Sun entering within the optical aperture during nominal operations, and is compatible with the **METOP** local solar time, including drift.

Satellite Level

A satellite-provided Sun shield, dedicated to the instrument, is used to :

- Prevent solar illumination of the baseplate radiator area ;

- Give a view to space for the baseplate radiator in the -X direction ;

- Prevent solar illumination of the deployed door at any time during nominal operations.
  This is a pre-requisite to get valid radiometric data from the instrument.

233. Thermal Control Budgets

233.1. Heater Power Budgets

The heater power budgets for the AVHRR/3 instrument are :

Module AVHRR/3	Heater Power Budget (Watts)			
	Meas. Mode Hot Case (EOL)	**Meas. Mode** Cold Case (BOL)	**Inert Mode *** Cold Case (BOL)	**Inert Mode *** Safe Mode (BOL)
Baseplate Operational Heaters	30 TBC_{MET}	30 TBC_{MET}	N/A	N/A
Baseplate Survival Heaters	N/A	N/A	TBD_{MET}	TBD_{MET}

* As far as survival heater power budget is concerned, AVHRR/3 Inert Mode case covers the AVHRR/3 Off mode case

Note : the patch heater power consumption in Decontamination Mode is accounted for at instrument level (see § 3.4.2.).

2.3.3.2 Instrument Thermal Diipation

The dissipation of the AVHRR/3 instrument is constant throughout the orbit and is (see § 3.4.2):

AVHRR/3 Thermal Dissipation (Watts)				
Satellite Nominal Operating Modes				Safe Mode
Minimum Dissipation		Maximum Dissipation		min / Max
Measurement Mode BOL	Other	Measurement Mode EOL	Decontamination Mode EOL	Inert / OFF EOL
25.9	0	27.0	47.0	0 / 9.8

2333. **Heat Exchange Budgets**

2.3.3.3.1. Conductive Heat Transfer.

The averaged calculated conductive heat transfer between the Payload Module structure and AVHRR/3 baseplateshallbeintherangeasshown:

Conductive Heat Transfer (Orbit Average, Watts) Between the METOP Structure and the AVHRR/3 Baseplate				
Satellite Nominal Operating Modes				Safe Mode
Minimum		Maximum		**min / Max**
Meas. Mode	other	**Meas.** Mode	**Deconta-** mination Mode	
TBD$_{MET}$	**TBD**$_{MET}$	**TBD**$_{MET}$	**TBD**$_{MET}$	**TBD**$_{MET}$

2.3.3.3.2. Joint Characteristics

N/A.

2.3.3.3.3. Radiative Heat Transfer

The averaged calculated radiative heat transfer between the Payload Module structure and the AVHRR/3 for different cases, as determined from the coupled analysis, are :

Radiative Heat Transfer (Orbit Average, Watts)					
AVHRR/3 Radiators	**Satellite Nominal Operating Modes**				**Safe Mode**
	Minimum Dissipation		**Maximum Dissipation**		**min / Max**
	Meas. Mode	**Other**	**Meas. Mode**	**Deconta-mination Mode**	
TBD$_{MET}$	**TBD**$_{MET}$	**TBD**$_{MET}$	**TBD**$_{MET}$	**TBD**$_{MET}$	**TBD**$_{MET}$

23.4. Thermal Interfaces

The conductive and radiative characteristics are represented by the Reduced Thermal Model delivered and integrated into the overall METOP Thermal Model as specified in § 2.3.4.6.

2.3.4.1. Conductive Interfaces

The total thermal conductance between AVHRR/3 and the Payload Module is TBD_{MET} W/K.

2.3.4.1.1. Description

The conductive interfaces are the mounting feet which are deflned in the Mechanical Interface Control Drawing § 2.1.4.).

1) The mounting foot area is :

a)	3 pads	25.40 x 25.4 mm²
b)	1 pad	20.57 x 25.4 mm²
c)	2 pads	22.09 x 25.4 mm²

2) Number of feet : 6

3) Thermal filler : Not required

2.3.4.1.2. Bolts

The bolts are defined in § 2.2.4.

2.3.4.1.3. Thermal Stand-Offs

Thermal stand-offs will be used between the AVHRR/3 mounting feet and the spacecraft balcony. The definition of these stand-offs is contained in the Thermal Interface Control Drawing (TBD_{MET}).

23.4.2. Radiative Interfaces

2.3.4.2.1. Radiator Characteristics

The AVHRR/3 radiator areas are :

Unit	Viewing Direction	Radiator Area Available@)	Radiator Area Used (m²)	Thermal FOV Achieved I'
Radiant Cooler *	-x	0.0501	0.0501	TBD_{MET}
Baseplate	-Z	0.135	TBD_{MET}	TBD_{MET}

* Not used for the instrument thermal control.

Thermal Field of View Occlusion

The interactions within the cryogenic radiator field of view, are illustrated in the following table.

Interaction With	View Factor	Sink Temperature (Tsink)
HIRS/4 Earth Shield	TBD_{MET}	TBD_{MET}
IASI Earth Shield	TBD_{MET}	TBD_{MET}

2.3.4.2.2. **Thermo-Optical Properties**

The external surfaces of the AVHRR/3 instrument, and the finishes used are given in the Thermal Interface Drawing (§ 2.1.4.). The baseplate -mechanical characteristics (planarity, materials...) is described in the Mechanical Interface Description Sections (§ 2.2.4.).

The thermo-optical properties of the finishes are given in the following table :

#	Acronym	Surface / Material	Solar Absorptance			IR
			BOL	EOL 5 yr.	EOL 6 yr. *	Emit-tance
1	BLKHNYTTT	Baseplate Black Honeycomb (Cal. Targets)	0.98	0.98	0.98	0.98
2	*Void*					
3	CHM306TTT	Sunshield, baseplate, feet / Black Paint Chemglaze Z306	0.92	0.94	0.95	0.87
4	AVSCHOTTT	Scan Motor Housing Cap	0.2	0.2	0.2	0.87
5	AVSCN1TTT	scan Mirror 1	0.46	0.46	0.46	0.135
6	AVSCN2TTT	Scan Mirror 2	0.03	0.03	0.03	0.135
7	AVTELETTT	Telescope, flat plate characteristics	0.85	0.85	0.85	0.93
8	AGTEFL5MO	External surfaces of the radiant cooler door / 5-mil Silverized Teflon (FSSM)	0.09	0.15	0.16	0.80
9	KAPTON5MO	±X surfaces /ITO Aluminized Kapton (5-mil)	0.59	0.72	0.74	0.80
10	EXTVDATTT	External surfaces of scan housing / Aluminized Kapton Tape	0.12	0.12	0.13	0.05
11	MS74WPTTT	Sun Shield / White Paint MS 74	0.22	0.40	0.24	0.90
12	GOLDIZTTT	Back of scan mirror / Gold Coated Aluminium	0.28	0.33	0.34	0.04
13	VACDALTTT	Internal surfaces of the radiant cooler door/ vacuum Deposit Aluminium	0.12	0.12	0.13	0.05
14	SCNMIRFRT	Front of Beryllium Scan Mirror	0.12	0.16	0.16	0.055
15	TBD	E-box blanket, surfaces of scan housing, optics top cover	TBD	TBD	TBD	TBD

* :Extrapolated from 5 year data

AVHRR/3 Material Thermo-Optical Properties

23.43. Thermal Heat Capacity

The thermal heat capacity of **AVHRR/3** is **TBD_{AVH} J/K.**

23.4.4. Instrument Temperature Measurement

For the thermal control Of the instrument baseplate radiator, the temperature sensors are **mounted on the** baseplate itself. These are used for control of the baseplate temperatures in all instrument modes.

Location : on the **AVHRR/3** baseplate and shown on **the** interface drawing **(TBD_{MET}).**

2.3.4.5. Heater Definition

The following heaters are implemented on the **AVHRR/3**:

Location	Number	Total Resistance (Ω at 25 deg. C) ±5%	Resistance Variation ΔR/R	Remark
Baseplate, Operational Heaters	TBD_{MET}	TBD_{MET}	TBD_{MET} / deg. C	METOP specific
Baseplate, Survival Heaters	TBD_{MET}	TBD_{MET}	TBD_{MET} / deg. C	METOP specific

Note : **the** outgassing heaters are to be considered as instrument internal heater (the related heater power is accounted for in the instrument power consumption budget), so are not used for **thermal control from** the satellite point of view.

2.3.4.6. Thermal Interface Models

A reduced model is required for **AVHRR/3** for the system **thermal** analysis, as specified in AD3 :

- Deployed **configuration**
- Stowed configuration (radiative)
- **Stowed** configuration (convective)

See AD6, AD7.

2.4. INSTRUMENT AND DISTURBANCE INTERFACES

Definitions

The coordinate system used is tbe Instrument Interface Reference Frame, F_{AVHRR}. The directions of the F_{AVHRR} axes are the same as the METOP Spacecraft Reference Frame Fs.

Static Imbalances

When the centre of mass of the rotating assembly is not aligned on the rotation axis, forces are, generated in the plane normal to the rotation axis and time varying with the angular-profile. The static imbalance is the product of the rotating assembly mass with the distance between the centre of mass and the rotation axis (unit : kg.m).

Dynamic imbalances

If the products of inertia of the rotating assembly with respect to the rotation axis are non zero, the rotation along this rotation axis generates torques along the axis normal to the rotation axis. Assuming that the rotation axis is the X axis, the dynamic imbalances are the cross products of inertia Ixz and Ixy (unit : $kg.m^2$).

2.4.1. Instrument Induced Disturbances and Shocks

2.4.1.1. Non-Recurring Transient Events

The AVHRR/3 non-recurring transients events are :

- Deployment of the radiant cooler door, to reach the in-orbit configuration of the instrument.
- Scanner motor ramp-up and ramp-down : those are to be considered as **contingency** cases (transition from Inert Mode to Off Mode and from Off Mode to Inert Mode).

They are described with the following tables.

2.4.1.1.1. Cooler Door Deployment

Cooler Door Deployment - Single Event Shock	
Rotation about	-Y axis
Deployment Duration	< 0.1 s
Impact Duration (impact of door on door stop)	Nominal : 0.00120 s. (see RD12) < 0.002 s.
Total moment of inertia of the moving part	0.00241 kg-m²
Compensation	None
Maximum uncompensated kinetic momentum	0.02 Nms (TBC_{AVH}) on the X axis 0.14 Nms on the Y axis 0.02 Nms (TBC_{AVH}) on the Z axis
Maximum residual force and torque at the instrument interface [2]	Fx < 75 N Fy < 47 N Fz < 145 N Cx < 0.20 Nm Cy < 0.55 Nm Cz < 0.01 Nm

2.4.1.1.2. Scanning Motor Ramp-Up

Scanning Mechanism - Ramp-Up (Contingency Case)	
Rotation about	-Y axis
Rotation rate	From 0 to 360 rpm over 25 ± 15 sec. Profile : with quasi-constant acceleration
Total moment of inertia of the rotating mirror	6.9 g.m² about the rotational axis
Compensation	None
Maximum uncompensated kinetic momentum	0.03 Nms on the X axis (TBC_{AVH}) 0.27 Nms on the Y axis 0.03 Nms on the Z axis(TBC_{AVH})
Maximum residual force at the instr. interface without the effects of static imbalances	0.01 N on all three axis
Maximum residual torque without the effects of dynamic imbalances	< 0.07 Nm on all three axis
Static imbalances (see definition § 2.4.)	7.2 E-6 kg.m
Torque due to residual dynamic imbalances (see definition § 2.4.)	< 0.0002 Nm

2 Those values are max values over a 10 ms period from cooler door release and are mainly due to high frequency (< 300 Hz) components. They include uncertainties (see RD12)

2.4.1.1.3. Scanning Motor Ramp-Down

Scanning Mechanism - Ramp-Down (Contingency Case)	
Rotation about	-Y axis
Rotation rate	**From 360 to 0 rpm over 35 ± 15 sec.** **Profile : with quasi-constant** acceleration
Total moment of inertia of the rotating mirror	6.9 **g.m²** about the **rotational** axis.
Compensation	**None**
Maximum uncompensated kinetic **momentum**	0.03 Nms on the X axis **(TBC_{AVH})** 0.27 Nms on the Y axis 0.03 Nms on the Z axis **(TBC_{AVH})**
Maximum residual force at the instr. interface without the effects of static imbalances	0.01 **N on all three axis**
Maximum residual torque without the effects of dynamic imbalances	**< 0.07 Nm on all three axis**
Static imbalances (see definition § 2.4.)	7.2 E-6 kg.m
Torque due to residual dynamic imbalances (see definition § 2.4.)	< 0.0002 Nm

2.4.1.2. Continuous / Recurring Transient Events : Scan Mechanism

A model has been developed to simulate the jitter performance of the scanner motor, using MATLAB, as illustrated in Figure 2.4.1/1. The input of this model is the bearing running torque versus time which is gathered experimentally.

Scanning Mechanism - Continuous -Rotation		
Rotation about	I-Y axis	
Rotation rate	360 rpm (6 Hz)	
Total moment of inertia of the rotating mirror	6.9 $g.m^2$ about the rotational axis	
Compensation	None	
Maximum uncompensated kinetic momentum	0.03 Nms on the X axis (TBC_{AVH}) 0.27 Nms on the Y axis 0.03 Nms on the Z axis (TBC_{AVH})	
Maximum residual force at the instr. interface without the effects of static imbalances	0.01 N on all three axis	
Maximum residual torque (See note below) without the effects of dynamic imbalances	0.001 Nm on the X axis Maximum on the Y axis : 10^{-2} Nm. standard deviation on the max. : 4. 10^{-3} Nm 0.001 Nm on the Z axis	
Residual torque vs. time	TBD_{AVH}	
Residual torque numeric description [3]	To be supplied by AVHRR/3	
Residual torque spectral decomposition (Y axis)	Frequency *(Hz)*	*Amplitude (Nm)*
	6.0	*0.005* (TBC_{AVH})
	TBD_{AVH}	TBD_{AVH}
Static imbalances (see definition § 2.4.)	7.2 E-6 kg.m	
Dynamic imbalances (see definition § 2.4.)	< 0.0002 Nm	

[3] This description (effective residual torque for each axis, including transitories, noise... and representative from 0 to 150 Hz.) shall be provided on a numeric tape with a sampling frequency greater than 1000 Hz ‘and an output format compatible with FORTRAN (double precision if possible).

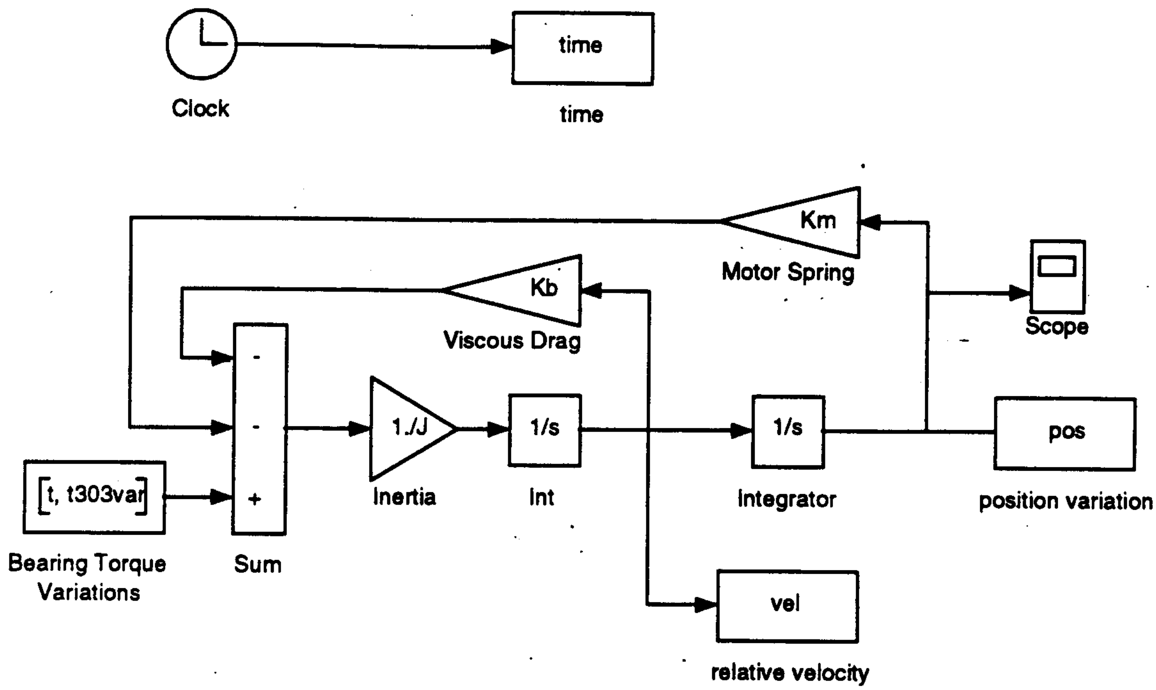


Figure 2.4.1/1 : AVHRR SCANNER MODEL - JITTER ANALYSIS

2.4.1.3. Flexible Modes

The AVHRR/3 does not have flexible mode on the X, Y, Z axes, in the range [0 , 10] Hz.

2.4.1.4. Induced High Frequency Disturbances (Micro-Vibrations)

METOP assumes compatibility of AVHRR/3 with the following METOP specific requirement.

The AVHRR/3 does not induce disturbances on any axis above 10^{-2} N (force) and 10^{-2} Nm (torque) above 10 Hz.

2.4.2. Compatibility With Satellite Dynamic Environment

2.4.2.1. General Mission Environment

The AVHRR/3, in any operation mode, **will** be exposed to the following in-orbit dynamic **environment** (frequency range **: 0 - 10 Hz)** :

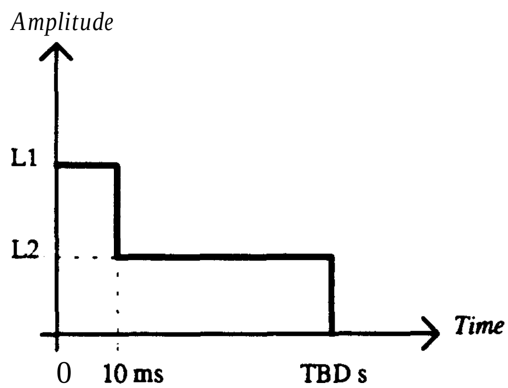
Linear acceleration on X, Y, **Z** axes at **METOP** satellite centre of mass *	**0.02 m / s²**
Angular rate about X, Y, Z axes	*7&g/s*
Angular acceleration about X, Y, **Z** axes	0.5 deg **/ s²**

* : With respect to the **METOP** satellite centre of mass, the **AVHRR/3 reference point (see § 2.1.4.1) is** located at :

$$\vec{G}_{SL}\vec{O}_{AVH} = \begin{bmatrix} -4.5 \\ -1.5 \\ -0.2 \end{bmatrix} \text{(metres)} \qquad (\text{TBC}_{\text{MET}})$$

2.4.2.2. Environment During Satellite Deployment Sequence

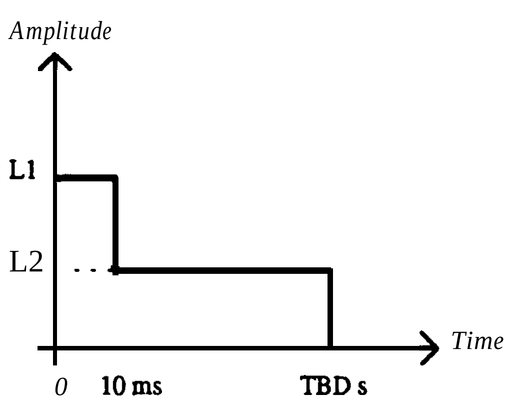
The instrument, in any operation mode, will be exposed to the following in-orbit linear and angular acceleration levels at the instrument interface reference point :



$$L1 \left| \begin{array}{c} X \\ Y \\ Z \end{array} \right. = \left| \begin{array}{l} 0.3\ m/s^2 \\ 1.0\ m/s^2 \\ 1.0\ m/s^2 \end{array} \right.$$

$$L2 \left| \begin{array}{c} X \\ Y \\ Z \end{array} \right. = \left| \begin{array}{l} 0.025\ m/s^2 \\ 0.100\ m/s* \\ 0.100\ m/s* \end{array} \right.$$

Maximum Linear Acceleration ***Amplitude Versus Time***



$$L1 \left| \begin{array}{c} X \\ Y \\ Z \end{array} \right. = \left| \begin{array}{l} 1.3\ deg./s^2 \\ 1.3\ deg./s^2 \\ 1.3\ deg./s* \end{array} \right.$$

$$L2 \left| \begin{array}{c} X \\ Y \\ Z \end{array} \right. = \left| \begin{array}{l} 0.65\ deg./s^2 \\ 0.50\ deg./s* \\ 0.50\ deg./s* \end{array} \right.$$

Maximum Angular *Acceleration Amplitude* ***Versus Time***

2.4.2.3. Micro-Vibration Environment

AVHRR/3 will be exposed to in-orbit TBD_{MET} disturbances with a frequency greater than 10 Hz.

3. COMMAND AND CONTROL, MEASUREMENT DATA, ELECTRICAL, EMC AND RFC INTERFACE DESCRJPTION

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3.1. ELECTRICAL INTERFACE OVERVIEW

The avionics interface between the METOP Payload Module (PLM) and the AVHRR/3 instrument is mainly handled via the Power Conditioning Unit (PCU) and the NOM Interface Unit (NIV).

Figure 3.1-1 gives an overview on the electrical interfaces between the PLM and the AVHRR/3.

For adaptation of the single ended interfaces of the AVHRR/3, a special grounding concept is described in § 3.8 (EMC).

The command and housekeeping budget for the instrument is as follows :

- 30 pulse discrete commands
- 15 digital B parameters, each 1 bit
- 22 analog parameters, each to be converted to.8 bits within NIU.

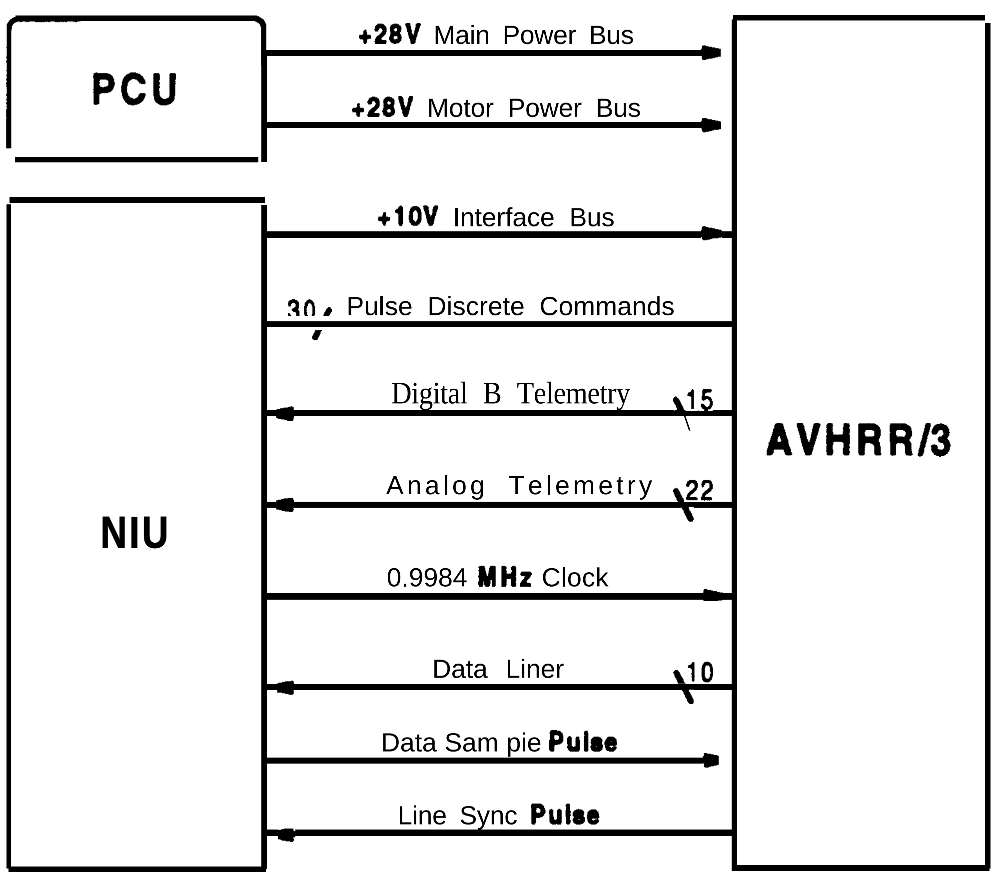

*Fig. 3.1-I : **PLM to A VHRR/3 Electrical Interface** Overview*

3.2. COMMAND AND CONTROL FUNCTIONAL DESCRIPTION

This section describes the command and control concept for the AVHRR/3 instrument.

'Command and Control' comprises the activities respective data flows for commanding of the instrument as well as for the acquisition of instrument housekeeping data.

Additionally, the instrument provides an interface of measurement data which is described in § 3.3.

These two data sets are treated separately in the METOP satellite.

Commanding of the instrument and acquisition of instrument housekeeping telemetry is performed under the control of the Payload Module Controller (PMC). Commands are distributed from the PMC via the PLM OBDH Bus to the NOAA Interface Unit (NIU) which translates or converts the functional and electrical interfaces to NOAA instruments. Vice versa housekeeping data are acquired by the NIU from the instrument and transmitted to ground.

Three data sets are made available by the instrument :
- Digital A data
- Digital B data
- Analog data

Digital A data are in the above sense measurement data' and are handled by NIU. They are not routed via the PLM OBDH Bus to the PMC and not used for housekeeping by the satellite.

Digital B and analog data are housekeeping data and only the Digital B data are controlled by the NIU. Both are reported to the ground via S-band telemetry.

3.2.1. Protocol

Not applicable for AVHRR/3.

3.2.2. Telecommands

Telecommands to the instrument shall be provided by the NIU.

The minimum time between two consecutive commands is 100 ms.

The instrument shall be commanded by Pulse Discrete Commands[1].

Pulse Discrete Commands shall be issued to the instrument one command at a time.

Any pulse ON condition may last for considerable time in case of a spacecraft anomaly. The instrument shall not be damaged by such an occurrence.

---

1 ***Pulse Discrete Command Definition***
The pulse discrete command **is normally used to change the state of a latching relay in the instrument. An ON or TRUE condition is issued in the form of a pulse to the instrument over a single line.**

The **METOP** satellite will provide capabilities for pre-programming of the **AVHRR/3** of up to 36 hours. The instrument **shall** Cope with this pre-programming **period,** and not require any intermediate command and control process (except thermal control).

The commands to operate the instrument shall be as listed in Table **3.2.2-** 1.

Note : The operational modes and sequences of commanding are .&fined in § 1.4 and 1.5.

3.22.1. **Telecommand Definition**

The satellite shall provide to the instrument all commands which are listed in Table 3.2.2-l.

Nr.	T&command	**Mnemo**	**Type**	**Remarks**
1	Scan Motor / Telemetry ON		Pulse	
2	Scan Motor / Telemetrv OFF		Pulse	Critical Command
3	Electronics / Telemetrv ON	1	Pulse	
4	Electronics / Telemetry OFF		Pulse	
5	Channel 1 Enable		Pulse	
6	Channel 1 Disable		Pulse	
7	Channel 2 Enable		Pulse	
8	Channel 2 Disable		Pulse	
9	Channel 3A Enable		Pulse	
10	Channel 3A Disable		Pulse	
11	Channel 3B Enable		Pulse	
12	Channel 3B Disable		Pulse	
13	Channel 4 Enable		Pulse	
14	Channel 4 Disable		Pulse	
15	Channel 5 Enable		Pulse	
16	Channel 5 Disable		Pulse	
17	Cooler Heater ON		Pulse	
18	Cooler Heater OFF		Pulse	
19	Telemetry Locked ON		Pulse	
20	Telemetry NOT Locked ON		Pulse	
21	Earth Shield Deploy		Pulse	Time constraint on this command see § 1.4.
22	Earth Shield Disable		Pulse	
23	Patch Control ON		Pulse	
24	Patch Control OFF		Pulse	
25	Channel 3A Select		Pulse	
26	Channel 3B Select		Pulse	
27	Voltage Calibrate ON		Pulse	Normally not used in flight
28	Voltage Calibrate OFF		Pulse	
29	Scan Motor High Mode		Pulse	
30	Scan Motor Low Mode		Pulse	Low mode nominally not used, Critical Command

Table 3.2.2-l : ***Telecommand Definition***

3.2.2.2. **Telecommand** Function Description

1. Scan Motor/Telemetry On

This command shall **turn** on the scan motor, scan drive electronics and the'first of the three parallel power switches for housekeeping telemetry. **Specifically,** this command applies power to the following **units** :

a) **Electronics** switch ing regulator
b) Motor **switch ing regulator**
c) DC/DC power converters
d) **± 15V** regulators
e) **+5V** motor logic regulator
f) Clock receiver
g) Motor logic
h) Analog telemetry circuits
i) Patch **temperature** control

2. Scan **Motor/Telemetry Off**

This command shall turn off the scan motor, scan drive electronics and the first of the three parallel power switches for housekeeping telemetry.

Note : **This command** is a critical command.

3. **Electronics/Telemetry On**

This command shall turn on the radiometer **electronics** (except **the** scan drive electronics) for all channels in the ENABLE mode, and the second of the three parallel power switches **for** housekeeping telemetry. Specifically, this command applies power to the following units :

a) Electronics switching regulator
b) DC/DC power converters
c) ± 15v regulators
d) **+5V** motor logic regulator
e) **+5V** electronics regulator
f) Analog telemetry circuits
g) A/D Converter
h) Scan timing logic
i) Clock receiver
j) Motor logic
k) Patch **temperature** control

4. **Electronics/Telemetry Off**

This command shall turn off the radiometer electronics and the second of the three parallel **power switches** for **housekeeping** telemetry.

5. **Channel l(0.63 µ) Enable**

If *"Electronics ON"* has been executed, this **command** applies power to :

a) **Channel** 1 pre-amplifier
b) **Channel** 1 post-amplifier

6. **Channel 1 (0.63 µ) Disable**

This command removes power from:

a) Channel 1 pre-amplifier
b) Channel 1 post-amplifier

7. **Channel 2 (0.86 µ) Enable**

IF *"Electronics ON"* has been executed, this command applies power to :

a) Channel 2 pre-amplifier
b) Channel 2 post-amplifier

8. **Channel 2 (0.86 µ) Disable**

This command removes power from :

a) Channel 2 pre-amplifier
b) Channel 2 post-amplifier

9. **Channel 3A (1.6 µ) Enable**

IF *"Electronics ON" has* been **executed**, this command applies power to :

a) Channel 3A pre-amplifier
b) Channel 3A post-amplifier

10. **Channel 3A (1.6 µ) Disable**

This command removes power from :

a) Channel 3A pre-amplifier
b) Channel 3A post-amplifier

11. Channel 3B (3.7 µ) Enable

If *"Electronics ON" has been executed this* command applies power to :

a) **Channel 3B** pre-amplifier

b) Channel **3B** post-amplifier

Note : See § 1.4.1 d for time delay constraint for this command.

12. Channel 3B (3.7 µ) Disable

This command removes power from :

a) Channel **3B** pre-amplifier

b) Channel **3B** post-amplifier

13. Channel 4 (10.8 µ) Enable

If *"Electronics ON" has* been executed, this command applies power to :

a) Channel 4 pre-amplifier

b) Channel 4 post-amplifier

c) Channel 4 detector bias

Note : See § 1.4.1 -d for time delay constraint for this command.

14. Channel 4 (10.8 µ) Disable

This command removes power from :

a) Channel 4 pre-amplifier

b) Channel 4 post-amplifier

c) Channel 4 detector bias

15. Channel 5 (12 µ) Enable

If *"Electronics ON" has* been executed, this command applies power to :

a) Channel 5 pre-amplifier

b) Channel **5** post-amplifier

c) Channel 5 detector bias

Note : See § 1.4.1-d for time delay constraint for this command.

16. Channel 5 (12 µ) Disable

This command removes power from :

a) Channel 5 pre-amplifier

b) Channel **5** post-amplifier

c) Channel 5 detector bias

17. Cooler Heater On

If *"Electronics/Telemetry ON", "Scan Motor/Telemetry ON", or "Telemetry Locked On" has been executed, this* command applies power to :

a) Radiator decontamination heater
b) Patch decontamination heater

Note : Channels 3B, 4 and 5 shall be disabled prior to this command (Cf. $1.4.1.)

18. Cooler Heater Off

'This command removes power from :

a) Radiator decontamination heater
b) Patch decontamination heater

19. Telemetry Locked On

This command shall turn on the third of three parallel power switches for housekeeping telemetry, thereby locking the telemetry ON independent of commands 1 through 4. Specifically, this command applies power to :

a) Electronics switch regulator
b) DC/DC power converters
c) ±15V regulators
d) +5V motor logic regulator
e) Clock receiver
f) Motor logic
g) Analog telemetry circuits
h) Patch temperature control

20. Telemetry Not Locked On

This command shall turn off the third of three parallel power switches for housekeeping telemetry, thereby returning the telemetry to the control of commands 1 through 4.

21. Earth Shield Deploy

This command applies power to :

a) Earth shield circuitry

Note.: This command shall be followed by the ***Earth Shield Disable*** command (see § 1.5.2.4.)

22. Earth Shield Disable

This command removes power from :

a) Earth shield circuitry

Note : This command follows the ***Earth Shield Deploy*** command.

23. Patch Control ON

If ***"Telemetry Locked On" (command*** # 19), ***"Scan Motor/Telemetry*** On" (# 1) or ***"Electronics/Telemetry On" (# 3) has been executed, this*** command applies controlled heat to :

a) Patch

24. Patch Control OFF

This command removes controlled heater power from :

a) Patch

25. **Channel 3A Select**

This command selects channel 3A for channel 3 data output from AVHRR/3.
Application of this command causes the Digital A patch temperature telemetry to toggle between actual temperature and reference on alternating scan lines.

26. **Channel 3B Select**

This command selects channel 3B for channel 3 data output from AVHRR/3.
Application of this command causes the Digital A patch temperature telemetry to read actual temperature every scan line.

27. **Voltage Calibrate ON**

If ***"Electronics/Telemetry ON" has*** been executed, this command :

a) Deactivates IR and daylight detectors

b) Removes bias from Channel 4 and 5 detectors

c) Provides simulated Barth scene and back-scan video for all enabled channels

Note : This command is used only for trouble-shooting purposes, so is not normally used in orbit.[2]

---

[2] **The switch-off command sequences as defined in § 1.5 consider that this command might have ken triggered during the satellite ground and in-orbit lifetime.**

28. Voltage Calibrate OFF

If *"Electronics/Telemetry ON"* has *been executed, this* command :

a) Activates IR and daylight detectors that are enabled

b) ~~Removes~~ Enables bias ~~from~~ to Channel 4 and 5 detectors

c) Deactivates simulated Earth scene and back-scan video

29. Scan Motor High Mode

If *"Scan Motor/Telemetry ON"* has *been executed,* this command :

a) Sets the motor switching regulator voltage to HIGH LEVEL

30. Scan Motor Low Mode

If *"Scan Motor/Telemetry ON" has* been *executed, this* command :

a) Sets the motor switch regulator voltage to LOW LEVEL

Note : This command is nominally not used, and is considered as a Critical Command.

3.23. Housekeeping Telemetry

This section describes the **AVHRR/3** Digital B and Analog Telemeuy.

3.2.3.1. General Requirements

The NIU shall only acquire the instrument-provided digital-B and analog HK data at any time when the instrument is in Heater / Decontamination Mode or Measurement Mode.'

The NIU will read out the following housekeeping **telemetry** formats from the instrument :

- **Analog** HK

- Digital HK ("Digital B").

The **NIU** will sample both analog and digital B housekeeping telemetry, with periods of :

- 16 seconds nominally

- up to **1/8 s** for any selected parameter on request.

Analog data shall be acquired and converted within the NIU to 8 bit digital information with a 5.12 V full scale resolution **(LSB** = 20 **mV).**

No instrument housekeeping data shall be monitored by the **METOP** satellite. Nevertheless the Digital B data will be checked on-board for verification of command execution.

Note : **The** following information shall be made available via the Satellite Packet for the on-ground processing of the **AVHRR/3** measurement data : Digital B telemetry point (Channel 3A / 3B Select Status).

3.2.3.2. **Digital** B Telemetry

The instrument shall provide the Digital B telemetry **as** listed in Table 3.2.3-l.

The Digital B telemetry points are available for monitoring as soon as all power interfaces are enabled and are ~~**independently**~~ independent of the instrument modes.

Each of the 15 Digital B telemetry points shall indicate the status of one of the pairs of commands of § 3.2.2.

Nr.	Telemetry Point Name	State		Remark
		Logic "1" (Low Voltage)	Logic "0" (High Voltage)	
1	Scan Motor/Telemetry Status	ON	OFF	
2	Electronics/Telemetry Status	ON	OFF	
3	Channel 1 Status	ON	OFF	
4	Channel 2 Status	ON	OFF	-
5	Channel 3A Status	ON	OFF	
6	Channel 3B Status	ON	OFF	
7	Channel 4 Status	ON	OFF	
8	Channel 5 Status	ON	OFF	
9	Channel 3A/3B Select Status	3A	3B	
10	Voltage Calibration Status	ON	OFF	
11	Cooler Heat Status	ON	OFF	
12	Scan Motor Mode Status	High Power	Low Power	
13	Telemetry Lock Status	Locked ON	Not Locked On	
14	Earth Shield Status	Deploy	Disable	
15	Patch Control status	ON	OFF	

Table 3.2.3-1: A *VHRR/3* **Digital** *B Telemetry*

3.2.3.3. Analog Telemetry

The AVHRR/3 provides analog telemetry channels as listed in Table 3.2.3-2 to monitor on the ground the health of the instrument. It shall be considered that telemetry of analog temperature, voltage and current (analog telemetry) will be valid by 16 s after switching-on of instrument telemetry, i.e. after *Scan Motor / Telemetry ON, Electronics / Telemetry ON or Telemetry Locked ON* command *has* been sent.

Typical valid data ranges and values are shown in Table 3.2.3-2.

The telemetry points shall be defined as following :

1.) Patch Temperature

This telemetry point measures the output from platinum temperature sensor located on the radiant cooler patch which contains the IR detectors. The amplifier gain / offset is adjusted for the patch temperature range.
This telemetry is valid for patch temperatures within the range specified in Table 3.2.3-2.

2.) ***Patch Temperature Extended***

This telemetry point measures the output from platinum temperature sensor located on the radiant cooler patch which contains the IR detectors. The amplifier gain/offset is adjusted for the extended temperamre range of the patch.

3.) Patch ***Power***

This telemetry point measures the power being applied to the control heater on the radiant cooler patch which contains the IR detector.

4.) ***Radiator Temperature***

This telemetry point measures the output from platinum temperature sensor located on the first stage (warmer stage) of the radiant cooler.

5.) - 8.) ***Blackbody Temperature 1,2,3,4***

This telemetry point measures the output from platinum temperature sensor Nr. 1 through 4 respectively, located on the blackbody calibration target.

9.) Electronics Current

This telemetry point measures the DC current load on the +28 V Bus (pins 1 and 2 on J3). This is directly proportional to the DC current into the power converters for the remain@ electronics not including the motor power supply. This current 'measurement also represents current supplied to the radiator window heaters, Earth shield release mechanism, and if ***Electronics / Telemetry ON or Telemetry Locked On have been*** commanded, ***the*** cooler decontamination heaters.

10.) Motor Current

This telemetry point measures the DC current load on the +28 V (Motor) Bus (pins 3 and 4 on J3). This is directly proportional to the DC current into the scan motor power supply. If ***Electronics / Telemetry OFF, Telemetry NOT Locked On*** **and** ***Scan Motor / Telemetry ON have been*** **commanded, this** current measurement will also include current supplied to the telemetry electronics and cooler decontamination heaters.

11.) Earth Shield Position

This telemetry point indicates the status of the radiant cooler Earth shield.

12.) Electronics Temperature

This telemetry point measures the output of the thermistor located inside the electronics box.

13.) ***Cooler Housing Temperature***

This telemetry point measures the output of the thermistor located on the radiant cooler housing.

14.) ***Baseplate Temperature***

'*This* telemetry point measures the output of the thermistor located on the baseplate.

15.) ***Motor Housing Temperature***

This telemetry point measures the output of the thermistor located on the motor housing.

16.) A/D Converter Temperature

This telemetry point measures the output of the thermistor located inside the A/D converter subsystem at the point of maximum operating temperature.

17.) Detector Bias Voltage Channel 4

This telemetry point measures a voltage directly proportional to the regulated ***- 12*** V DC which supplies the channel 4 IR detector bias current.

18.) Detector Bias Voltage Channel 5

This telemetry point measures a voltage directly proportional to the regulated ***-12*** V DC which supplies the channel 5 IR detector bias current.

19.)· Blackbody Temperature, IR Channel 3B

This telemetry point measures the output of a sample-and-hold circuit which samples the IR channel ***3B analog data*** signal once each scan line when viewing the blackbody calibration target.

20.) ***Blackbody Temperature, IR Channel 4***

This telemetry point measures the output of a sample-and-hold circuit which samples the IR channel 4 analog data signal once each scan line when viewing the blackbody calibration target.

21.) ***Blackbody Temperature, IR Channel 5***

This telemetry point measures the output of a sample-and-hold circuit which samples the IR channel 5 analog data signal once each scan line when viewing the blackbody calibration target.

22.) ***Reference Voltage***

This telemetry point measures a DC voltage directly proportional to the **+6.4** V reference voltage source in the electronics.

will approximate

The analog telemetry ~~shall have~~ **the performance** as defined in Table **3.2.3-2.** The transfer function between physical range and voltage range is part of the deliverables / as-built data.

Nr.	Telemetry Point Name	Physical Range	Remarks
1	Patch Temperature	+0.2 v = 90.7 deg. K +5.0 v = 115.5 deg. K	
2	Patch Temperature Extended	+0.2 V = 99.4 deg. K +5.0 V = 316.0 deg. K	
3	Patch Power	+0.2 V = 0.08 mW +5.0 v = 50.0 mW	
4	Radiometer Temperature	+0.2 V = 148.7 deg., K +5.0 V = 317.3 deg. K	
5	Blackbody Temperature 1	+0.2 V = 5.086 deg. C +5.0 v = 44.974 deg. c	
6	Blackbody Temperature 2	+0.2 V = 5.086 deg. C +5.0 v = 44.974 deg. c	
7	Blackbody Temperature 3	+0.2 V = 5.086 deg. C +5.0 v = 44.974 deg. c	
8	Blackbody Temperature 4	+0.2 V = 5.086 deg. C +5.0 v = 44.974 deg. c	
9	Electronics Current	+0.2 v = 39.3 mA +5.0 V = 982.5 mA	
10	Motor Current.	+0.2V = 12 mA +5.0 V = 300 mA	
11	Earth Shield Position	> 4.0 V open 2.0 - 4.0 V in between < 2.0 v closed	
12	Electronics Temperature	+0.2 V = 38.73 deg. C +5.0 V = 10.8 deg. C	
13	Cooler Housing Temperature	+0.2 V = 33.24 deg. C +5.0 v = 3.95 deg. c	
14	Baseplate Temperature	+0.2 V = 33.24 deg. C +5.0 V=3.95 deg. c	
15	Motor Housing Temperature	+0.2 V = 33.24 deg. C +5.0 v = 3.95 deg. c	
16	A/D Converter Temperature	+0.2 v = 59.73 deg. c +5.0 V = 8.27 deg. C	
17	Detector #4 Bias Voltage	+1.923 v = -13 v +2.384 V = -11 V	
18	Detector #5 Bias Voltage	+1.923 = -13 v +2.384V = -11V	
19	Blackbody Temp. IR Ch. 3B	To be calibrated	Note1
20	Blackbody Temp. IR Channel 4	To be calibrated	Note 1
21	Blackbody Temp. IR Channel 5	To be calibrated	Note1
22	Reference Voltage	+0.2 V = 0.266 V +5.0 V = 6.657 V	

Note 1 : Data valid only when the patch temperature is in its regulated range and the channel is enabled.

Table 3.2.3-2 : ***Analog Telemetry***

Following are the Analog Telemetry status as function of the different telecommands.

	Command	Analog Telemetry Status	Timing	(0
1	Scan Motor/ Telemetry On	***Motor Current TM increases*** by **150-250 mA, depending on** Motor Mode. An additional 130 **mA** increase occurs if ***Electronics/Telemetry OFF*** and ***Telemetry NOT Locked ON have*** been commanded.		(1
2	Scan Motor / Telemetry Off	***Motor Current TM decreases*** by **150-250 mA, depending on** Motor Mode. An additional 130 **mA** decrease occurs if ***Electronics/Telemetry OFF*** **and** ***Telemetry NOT Locked ON have*** **been commanded.**		(1
3	Electronics / Telemetry On	***Electronics Current TM*** increases by approx. ***320*** **mA,** (not including current for enabled channels). ***Reference Voltage TM*** becomes valid. An additional 130 **mA** increase occurs if ***Motor/Telemetry OFF*** and ***Telemetry NOT Locked ON have*** been commanded		
4	Electronics / Telemetry dff	***Electronics Current TM decreases*** by approx. ***320*** **mA,** (not including current for enabled channels). ***Reference Voltage TM*** not **valid.** An additional ***130*** **mA** ***decrease occurs*** if ***Motor / Telemetry OFF*** and ***Telemetry NOT Locked ON have*** been commanded.		
5	Channel 1 Enable	***Electronics Current TM*** increases by approx. **40 mA.**		(2
6	Channel 1 Disable	***Electronics Current TM decreases*** by approx. **40 mA.**	.	(2
7	Channel *2* Enable	***Electronics Current TM*** increases by approx. **40 mA.**		(2
8	Channel 2 Disable	***Electronics Current TM*** decreases by approx. **40 mA.**		(2
9	Channel 3A Enable	***Electronics Current TM*** increases by approx. 50 **mA.**		(2
1!O	Channel 3A Disable	***Electronics Current TM decreases*** by approx. 50 **mA.**		(2
11	Channel 3B Enable	***Electronics Current TM*** increases by approx. **40 mA.** ***BB Temp IR CH 3B TM*** becomes valid if Patch is in “regulation” (105 deg. K).		(2
12	Channel 3B Disable	***Electronics Current TM*** decreases by approx. **40 mA.** ***BB Temp IR CH 3B TM*** not valid		(2
13	Channel 4 Enable	***Electronics Current TM*** increases by approx. 60 **mA.** ***BB Temp IR CH 4 TM*** **becomes** valid if Patch is **in "regulation"** (105 deg. K).		(2
14	Channel 4 Disable	***Electronics Current TM decreases*** by approx. ***60*** **mA.** ***BB Temp IR CH 4 TM*** not valid		(2
15	Channel *5* Enable	***Electronics Current TM*** increases. by approx. 60 **mA.** ***BB Temp IR CH 5 TM*** becomes **valid** if Patch is in “regulation” (105 deg. K).		(2
16	***Channel 5*** Disable	***Electronics Current TM decreases*** by approx. 60 **mA.** ***BB Temp IR CH 5 TM*** not **valid.**		(2

Table 3.2.3-3 : Instrument Analog Telemetry vs. Commands (1/2)

	Command	Analog **Telemetry Status**	Timing	(0)
17	Cooler Heater On	***Electronics Current TM*** increases by approx. ***830* mA** until Patch and Radiator temperatures reach approx. **+30** deg. C.		(3)
18	Cooler Heater Off	***Electronics Current TM* decreases** by approx. ***830* mA** if Patch and Radiator temperatures are less than approx. **+30** deg. C.		(3)
19	Telemetry Locked On	***Electronics Current TM* increases by approx. 130 mA if *Electronics/Telemetry OFF has* been *commanded.*** ***Motor Current TM* decreases** by approx. **130 mA if *Motor / Telemetry ON has*** been commanded.		
20	Telemetry NOT Locked On	***Electronics Current TM decreases*** by approx. 130 **mA** if ***Electronics / Telemetry OFF has* been *commanded.*** ***Motor Current TM*** increases by approx. 130 **mA** if ***Motor / Telemetry ON has been* commanded.**		
21	Earth Shield Deploy	***Electronics C&rent TM*** increases by approx. 2.0 A until Earth Shield reaches full-open position. If Telemetry active, ***Earth Shield Position TM*** indicates "OPEN".		(4.
22	Barth Shield Disable	If Barth Shield is stuck "Closed" and ***Earth Shield Deploy*** has been commanded, ***Electronics Current TM decreases*** by approx. ***2.0*** A. No change in normal mode.		
23	**Patch Control On**	If cooling load is present on Radiant Cooler, ***Patch Temp TM's*** will stabilize at approx. 105 deg. K.		
24	**Patch Control Off**	***Patch Temp TM's*** will "float" as a function of cooling / heating load on Radiant Cooler.		
25	Channel 3A Select	**No change**		
26	Channel 3B Select	**No change**		
27	Voltage Calibration on	Enabled **IR Channels *"BB Temp" TM`s*** will measure approx. 0.5 V (0.4 V for ***BB Temp IR CH 3B TM***).		
28	Voltage Calibration Off	Enabled **IR** Channels ***"BB Temp" TM's*** will return to nominal values.		
29	Scan Motor High Mode	**If *Motor / Telemetry ON has*** been commanded, ***Motor Current TM*** increases to 200-250 **mA.**		(1)
30	Scan Motor Low Mode	If ***Motor/ Telemetry ON has*** been commanded, ***Motor Current TM* decreases to 150-200 mA.**		(1)

Notes :

0) Timing is **TBD$_{AVH}$**.

1) Actual Motor Current varies from unit to unit

2) Electronics / Telemetry ON must be commanded.

3) If ***Telemetry NOT Locked ON*** and ***Electronics /Telemetry OFF have*** been commanded, current increase will appear on ***Motor Current TM.***

4) "Telemetry Active" means ***Telemetry Locked ON, <u>OR</u> Motor/ Telemetry ON, <u>OR</u> Electronics / Telemetry ON have*** been **commanded.**

Table 3.2.3-3 : Instrument Analog Telemetry vs. Commands (2/2)

3.2.4. Tekcommand Verification

No check shall be performed by the spacecraft to verify whether the command is consistent with the active instrument mode.

The execution of each command shall be verified by the spacecraft. The interrelationship between commanding and the verification of a command in the Digital B telemetry is defined in Table 3.2.4-1. The column 'Timing'* specifies the maximum time delay between the arrival of a command in the instrument and change of the corresponding Digital B parameter.

The parameter value acquired apart from the routine HK cycle will be discarded after verification and not transmitted to ground. Execution failure will be reported in the history area.

In case of a command execution error by the AVHRR/3, the PLM NIU shall report this error to the ground and no autonomous corrective action, including AVHRR/3 switch-off, shall be performed by the spacecraft.

	Command	constraint	Command Verification Digital B	Timing
1	Scan Motor/Telemetry On	clock must be present	Sean Motor/ TM Status " ON "	< 60 ms
2	Scan Motor/Telemetry Off		Scan Motor/ TM Status " OFF "	< 60 ms
3	Electronics/Telemetry On	See above.	Electronics/ TM Status " ON "	< 60 ms
4	Electronics/Telemetry Off		Electronics/ TM Status " OFF "	< 60 ms
5	Channel 1 Enable	To be executed after Electronics/TM On	Channel 1 Status " ON "	< 60 ms
6	Channel 1 Disable		Channel 1 Status " OFF "	< 60 ms
7	Channel 2 Enable	To be executed after Electronics/TM On	Channel 2 status " ON "	< 60 ms
8	Channel 2 Disable		Channel 2 Status " OFF "	< 60 ms
9	Channel 3A Enable	To be executed after Electronics/TM On	Channel 3A Status " ON "	< 60 ms
10	Channel 3A Disable		Channel 3A Status " OFF "	< 60 ms
11	Channel 3B Enable	To be executed after Electronics/TM On	Channel 3B Status " ON "	< 60 ms
12	Channel 3B Disable		Channel 3B Status " OFF "	< 60 ms
13	Channel 4 Enable	To be executed after Electronics/TM On	Channel 4 Status " ON "	< 60 ms
14	Channel 4 Disable		Channel 4 Status " OFF "	< 60 ms
15	Channel 5 Enable	To be executed after Electronics/TM On	Channel 5 Status " ON "	< 60 ms
16	Channel 5 Disable		Channel 5 Status " OFF "	< 60 ms
17	Cooler Heater On	To be executed after Cmd Nr. 1 or Cmd Nr. 3 or Cmd Nr. 19	Cooler Heat Status " ON "	< 60 ms
18	Cooler Heater Off		Cooler Heat Status " OFF "	< 60 ms
19	Telemetry Locked On	See above.	Telemetry Lock Status " LOCKED ON "	< 60 ms

Table 3.2.4-1: Tekommand Verification (1/2)

	Command	Constraint	Command Verification Digital B	Timing
20	Telemetry NOT Locked On		Telemetry Luck Status " NOT LOCKED ON "	< 60 ms
21	Earth Shield Deploy	Outgas Heater must be OFF	Earth Shield Status " DEPLOY "	< 60 ms
22	Earth Shield Disable		Earth Shield Status " DISABLE "	< 60 ms
23	Patch Control On	To be executed after Cmd Nr. 1 or Cmd Nr. 3 or Cmd Nr. 19	Patch Control Status " ON "	c 60 ms
24	Patch Control Off		Patch Control Status " OFF "	< 60 ms
25	Channel 3A Select		Channel 3A/3B Select Status " 3A "	< 60 ms
26	Channel 3B Select		Channel 3A/3B Select Status " 3B "	< 60 ms
27	Voltage Calibration On		Voltage Calibration Status " ON "	< 60 ms
28	Voltage Calibration Off		Voltage Calibration status " OFF "	< 60 ms
29	Scan Motor High Mode	To be executed after Scan Motor/TM On	Scan Motor Mode Status " HIGH "	< 60 ms
30	Scan Motor Low Mode	To be executed after Scan Motor/TM On	Scan Motor Mode Status " LOW "	< 60 ms

Table *3.2.4-1: Telecommand Verification (2/2)*

3.2.5. METOP Specific Thermal Control Electrical Interfaces

The thermal concept for the AVHRR/3 on METOP is described in § 2.3.1.

The nominal and survival thermal control of the AVHRR/3 baseplate is under the responsibility of the satellite through the PLM Thermal Control Unit (TCU).

METOP specific thermistor, heater and thermostat-controlled survival hardware is used for this purpose, but none realises an electrical interface with the AVHRR/3 (TBC_{MET} for the nominal heaters and thermistors).

In addition., the AVHRR/3 motor housing heaters are not used for METOP (J33 connector).

As a conclusion, there is no electrical interface between the AVHRR/3 and the PLM for the instrument thermal control.

3.2.6. Satellite Services

Note : Satellite Services are defined as all Command and Control tasks which will be performed by the PLM or the SVM to support instrument operations.

3.2.6.1. Synchronization

Note : the synchronization of measurement data read-out is defined in § 3.3.2.

The NIU shall provide to the instrument a clock signal of 0.9984 MHz. This signal shall also be supplied in AVHRW3 OFF Mode, but in this mode, the frequency of the signal may deviate from the above value by ± 10%.

3.2.6.2. Channel Switching (Day/Night Flag)

Channel 3A and Channel 3B shall be switched-over by the spacecraft.

This switch-over is independent from the actual instrument status (i.e. no synchronization with the beginning of a line scan)

Note : The time accuracy of the switch-over command is as per § 3.2.2.

The AVHRR/3 shall deliver data of the selected sensor (3A/3B) within 15 ms of the beginning of the switch-over command pulse.

3.3. MEASUREMENT DATA TRANSFER FUNCTIONAL DESCRIPTION

The measurement data of the AVHRR/3 are provided at the digital A interface and are acquired and packetized by the NIU prior to storage and transmission to the ground. Measurement data are not routed via the OBDH bus to the PMC and are not used for instrument housekeeping.

3.3.1. Data Rate

AVHRW3 is a radiometer with 6 channels but only 5 channels are operated at a time. Each of them parallelly delivers IO-bit words to the platform, and the resulting 50 bits are named a sample.

Within one scan (i.e. 1/6 = 166.67 ms), AVHRR/3 delivers 2071 samples of measurement data. The apparent mean data rate is then 62 1.300 kbps.

The peak data rate is 1996.8 kbps (total for the 10 lines).

Note : These data are not packetized within the instrument.

3.3.2. Measurement Data Acquisition

The measurement data interface consists of the :

- line synchronization pulse, from the AVHRR/3;
- data sample pulse, from the NIU;
- 10 data lines, from the AVHRR/3.

The line synchronization is sent from the AVHRR/3 to the NIU. The leading edge shall be used as reference for each AVHRR/3 start of scan The characteristics of this Line Synchronization Pulse is described in § 3.5.

in response, the NIU generates data sample pulses back to the AVHRR/3, that specify the exact time for simultaneously sampling the AVHRR/3 analog data channels. The analog data are digitized by the AVHRR/3 and are presented to the NIU on 10 data lines at 5 predetermined times following each sample pulse (corresponding to 5 of 6 AVHRR/3 channels). The characteristics of those AVHRR/3 Data Lines are described in § 3.5.

The data sample pulses will be issued in accordance with Table 3.3.2-l. First and last sampling pulse of the sample period are defined relative to the line synchronisation pulse in terms of 998.4 kHz clock cycles. The characteristics of this Data Sample Pulse is described in § 3.5..

During sampling periods, the sample pulse spacing will be 25 (998.4 kHz) clock cycles.

The NIU will read-out the 10 bit parallel data lines 5 times after each data sample pulse as shown in Figure 3.3.2-l.

33.3. Measurement (Digital A) Data Format

The content of the analog channel is the following (see Table 3.3.2-l) :

A) Space View.

The **AVHRR/3** scan timing allows for 10 samples corresponding to the video channel outputs during the deep space view part of the scan, i.e. space view data from channels **1, 2, 3A** or 3B (the one that is selected), 4 and 5 are generated.

If IR **channels** are not enabled data are not representative.

B) Electronic Ramp Calibration

The **AVHRR/3** scan timing allows for 1 sample correspond@ to the video channel outputs, resulting from a ramp calibration signal, i.e. ramp calibration data from channels **1, 2, 3A** or 3B (the one that is selected), 4 and 5 are generated (See § 1.2.3.2.).

If IR channels are not enabled, data are not representative.

C) Earth View.

The **AVHRR/3** scan timing allows for 2 048 samples corresponding to the video channel outputs during the Earth view part of the scan, i.e. Earth view data from channels 1.2, 3A or 3B (the one that is selected), 4 and **5** are generated.

If IR channels are not enabled, data are not representative.

D) IR Target Temperature.

The **AVHRR/3 scan** timing allows for 1 sample corresponding to the temperature of the back scan calibration target, measured using four platinum resistance detectors.

The signal from each of **the** detectors in the radiometer **housing** calibration target (**IR** Target Temperature) is inserted into the composite analog video signal in channels **3B,** 4 and **5** only, one signal per scan line (the data acquired from channels 1.2 and 3A are not representative). The signal from the first temperature detector is inserted in the first scan line, the signal from the second temperature detector is **inserted** in the second scan line... until all detectors have been interrogated. The scan line immediately following the line which contains the last temperature detector contains zeros (0) in at least the first 8 **significant** bit locations.

E) Cooler Patch Temperature.

When Channel 3A is selected, the signal is the Cooler Patch Temperature telemetry value only for the first channel (1), and zero (0) for the others **(TBC_{AVH})**.

When Channel 3B is selected the signal is the Cooler Patch Temperature telemetry value for all channels **(TBC_{AVH})**.

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F) Back Scan Target IR Data

The **AVHRR/3** scan timing allows for 10 samples corresponding to the video channel outputs during the ~~OCT~~ ICT (Internal Calibration Target) view part of the scan, i.e. IR calibration data from channels **3B,** 4 and 5 are generated (the data acquired from channels **1, 2** and 3A are not representative).

A) Space View.

The AVHRR/3 scan timing allows for 10 samples corresponding to the video channel outputs during the deep space view part of the scan, i.e. space view data from channels 1, 2, 3A or 3B (the one that is selected), 4 and 5 are generated.

B) Electronic Ramp Calibration.

The AVHRR/3 scan timing allows for 1 sample corresponding to the video channel outputs, resulting from a ramp calibration signal, i.e. ramp calibration data from channels 1, 2, 3A or 3B (the one that is selected), 4 and 5 are generated (See § 1.2.3.2.).

C) Earth View.

The AVHRR/3 scan timing allows for 2 048 samples corresponding to the video channel outputs during the Earth view part of the scan, i.e. Earth view data from channels 1, 2, 3A or 3B (the one that is selected), 4 and 5 are generated.

D) IR Target Temperature.

The AVHRR/3 scan timing allows for 1 sample corresponding to the temperature of the back scan calibration target, measured using four platinum resistance detectors.

The signal from each of the detectors in the radiometer housing calibration target (IR Target Temperature) is inserted into the composite analog video signal in channels 3B, 4 and 5 only, one signal per scan line (the data acquired from channels 1, 2 and 3A are not representative). The signal from the first temperature detector is inserted in the first scan line, the signal from the second temperature detector is inserted in the second scan line... until all detectors have been interrogated. The scan line immediately following the line which contains the last temperature detector contains zeros (0) in at least the first 8 significant bit locations.

E) Cooler Patch Temperature. replace entry E

The AVHRR/3 scan timing allows for 1 sample corresponding to the temperature of the cooler patch.

The signal from the temperature detector is inserted into the composite analog video signal in channels 3B, 4 and 5 only, one signal per scan line (the data acquired from channels 1, 2 and 3A are not representative). When channel 3A is selected (command #25_see section 3.2.2 *Telecommands*), *the* cooler patch temperature value in the digital A data toggles between the telemetry value in one scan line and a value near zero counts in the next consecutive scan line. The “near zero counts” value is intended to be signal ground level and typically does not exceed 10 counts. When Channel 3 B is selected (command #26), the cooler patch temperature telemetry value is in the digital A data every scan line.

F) ~~Back Scan~~ Target IR Data.

The AVHRR/3 scan timing allows for 10 ~~samples corresponding~~ to the video channel outputs during the ICT (Internal Calibration ~~Target) view part of the scan, i.e. IR calibration data from channels 3B, 4 and 5 are generated (the data~~ acquired ~~from channels 1, 2 and 3A are not representative)~~.

Bit Position

~~The MSB of radiometric data is located on data line 1 for each channel.~~

The LSB ~~of radiometric data~~ is located on data line 10 for each channel.

Bit Position

The MSB of radiometric data is located on data line 1 for each channel.

The LSB of radiometric data is located on data line 10 for each channel.

AVHRR Output Information	Start of First Sample Pulse		Start of Last Sample Pulse		# of Samples Generated
	Time (msec.)	Clock Counts	Time (msec.)	Clock Counts	
Detector : Space View	+2.529	2 525	+2.754	2 750	10
Electronic Ramp Cal.	+3.756	3 750	+3.756	3 750	1
Detector : Earth View	+8.614	8 600	+59.871	59 775	2 048
TLM : IR Target Temp.	+65.780	65 675	+65.780	65 675	1
TLM : Patch Temp.	+66.006	65 900	+66.006	65 900	1
Detector : IR Back Scan	+118.064	117 875	+118.289	118 100	10

Notes : apply to 3.3.2-1 move up

(1) T_0 is the leading edge of the AVHRR/3 line sync.

(2) T = 1.00160256 µs = one 0.9984 MHz clock period = one count

(3) All "Times" and "Counts" are in appropriate units after TO

(4) AVHRR/3 Scan Period = 1/6 second = 166.67 ms

(5) Sample Pulse Spacing = 25T during sample periods

(6) Due to the asynchronous characteristics of the AVHRR line sync. pulse, the first time unit or count unit (unit #1) may be shorter than T. The first unit is defined as time between TO and the subsequent rising edge of the 0.998 MHz clock.

Table 3.3.2-1 : AVHRR/3 Sampling Sequence

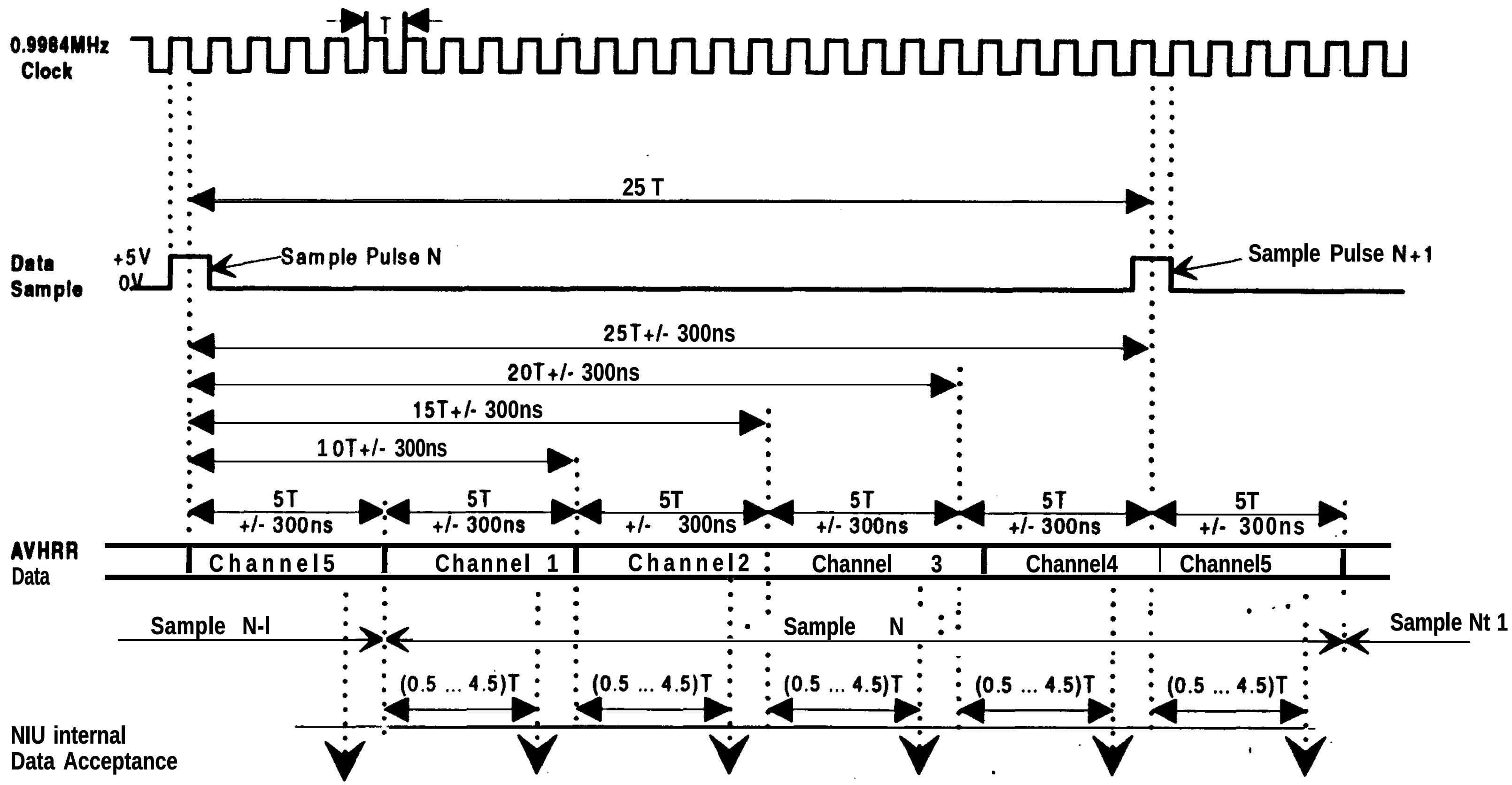


Figure 3.3.2-1 : AVHRR/3 Measurement Data Read-out

3.4. POWER ELECTRICAL INTERFACES

3.4.1. Overview

The AVHRR/3 instrument requires the following power interfaces :

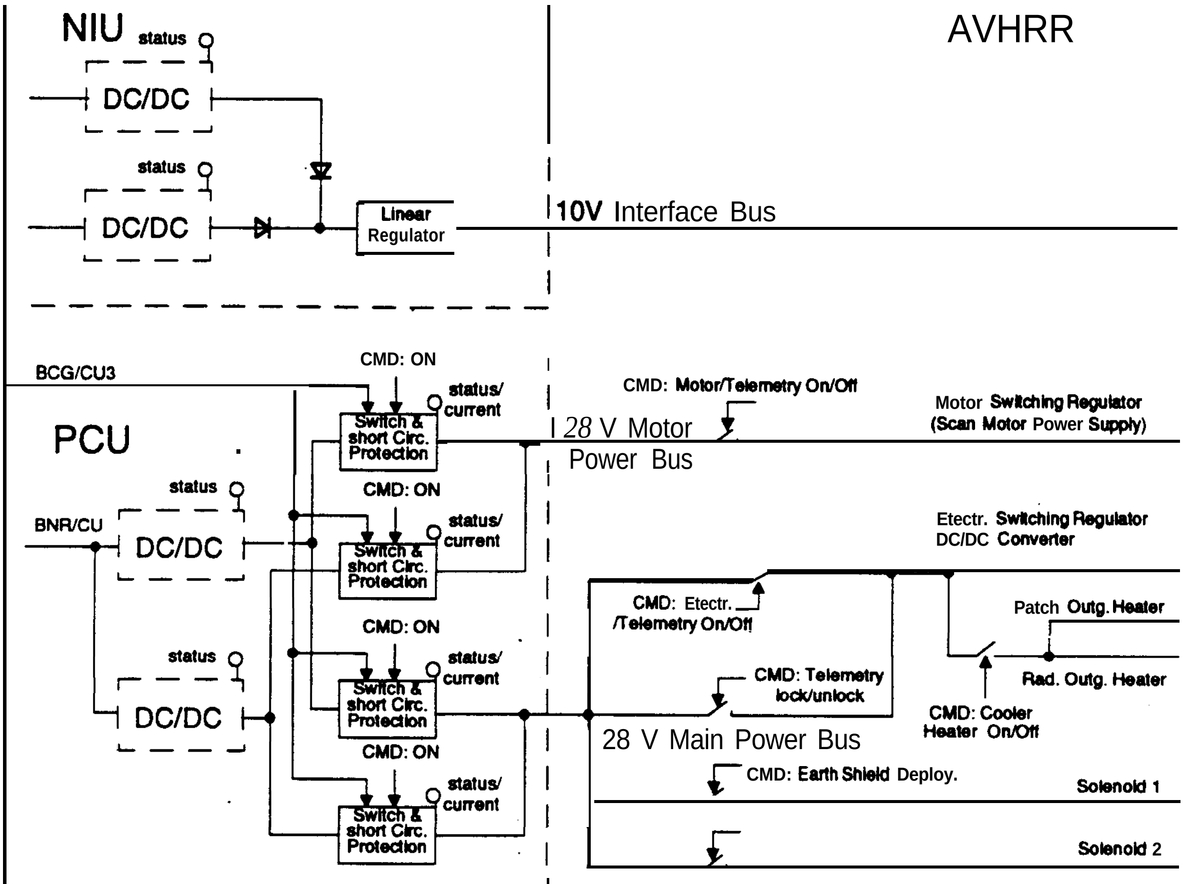
- A regulated *+28 Volt Main Bus with* high quality power as primary source for the instrument.

- A regulated *+28 Volt Motor Bus with high* quality power for the supply of'the scan motor.

- A regulated *+10 Volt Interface Bus* for powering of standard control interfaces in the instrument.

The +28 V Main and Motor Power Bus is conditioned by the internally redundant Power Conversion Unit (PCU) and is individually switched and protected. The +10 V Interface Bus is provided by the NIU. This is illustrated in Fig. 3.4.1-1.

Figure 3.4.1-2 details the AVHRR/3 internal power distribution.



Details on AVHRR/3 side are illustrated in Figure 3.4.1-2.

*Fig. 3.4.1-I : **AVHRR/3** Power Distribution Diagram*

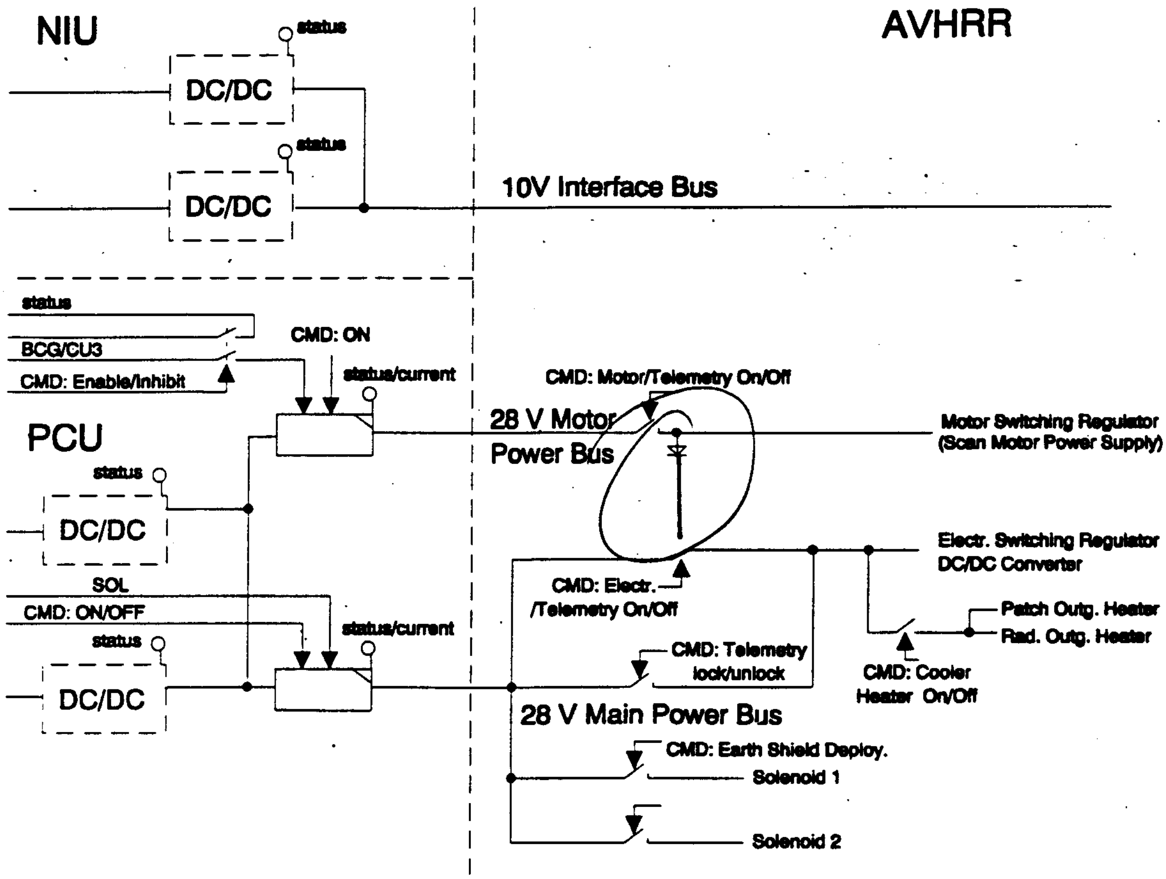


Fig. 3.4.1-1 : AVHRR/3 Power Distribution Diagram

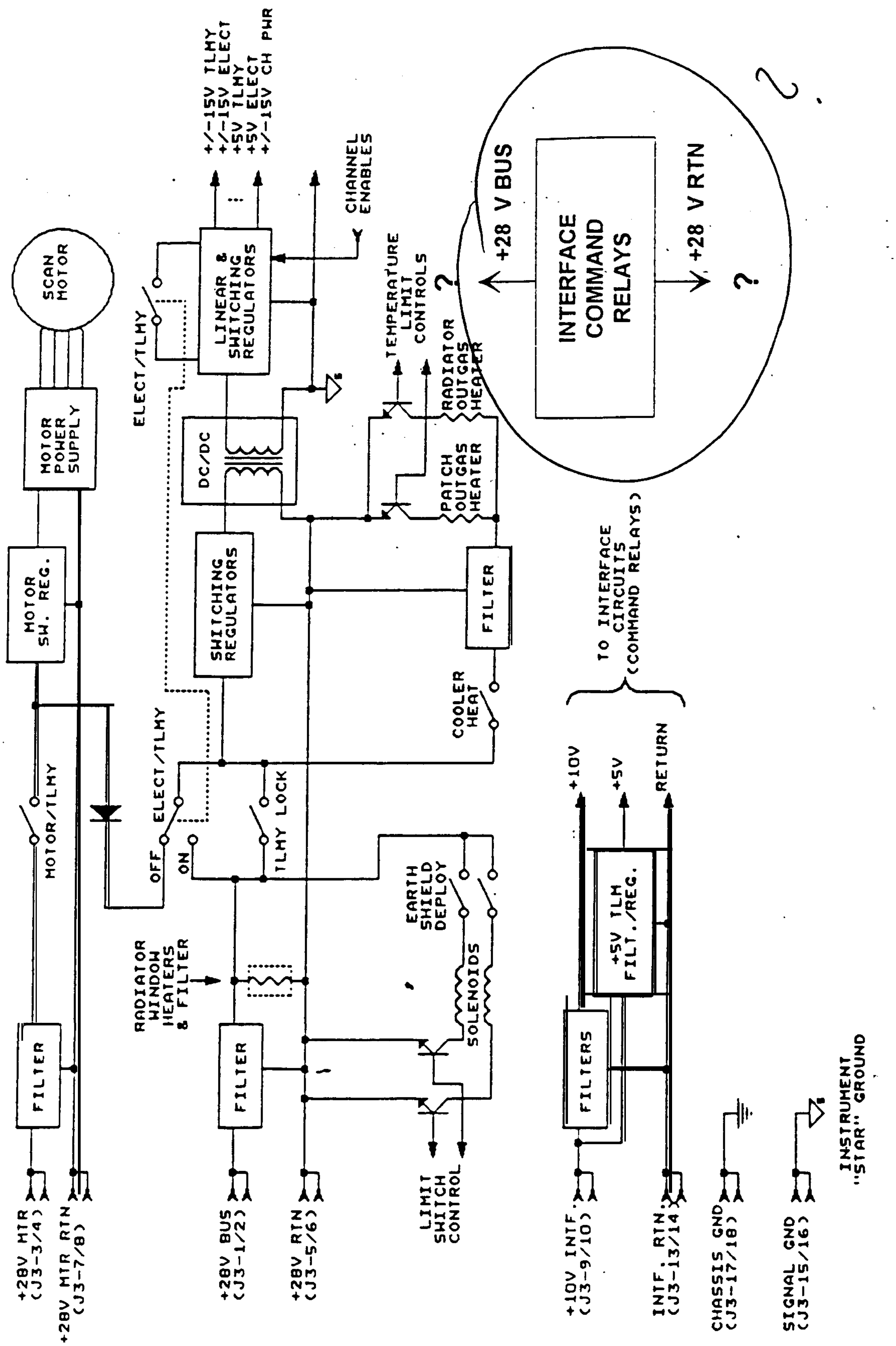


*Fig. 3.4.1-2 : A **VHRR/3 Internal** Power **Distribution** Diagram*

3.4.2. Power Demand

The actual power demands for AVHRR/3 on the individual power busses for BOL & EOL during all modes ~~and required outlet dimensions are~~ defined in Table 3.4.2-l Power Consumption Data Sheet.

The power budget for the thermal control of the baseplate is not part of the instrument power budget (see § 2.3.3.1.).

Definitions

Typical Beginning.of Life Power

Power expected to be measured during instrument acceptance test, = basic power.

Worst Case End of Life Power

Specified power the instrument shall never exceed (except in case of failure).

Mean ***Power***

Steady state power consumed when the power bus is set at its mean voltage and with a 25 deg. C temperature.

Min. / Max Power

Min. / max. steady state power consumed as a function of power bus input voltage and instrument temperature.

Peak Power

Total power consumed during a peak, i.e. corresponding to an event of finite duration during the considered functional mode. The peak power is given at mean power bus voltage and with a 25 deg. C temperature. The peak power is characterized by a peak duration and / or a peak repetition duty cycle.

Failure Power Consumption

Maximum permanent power that will be consumed without triggering an internal protection or without leading to a fuse blowing.

dP/dV @ 25 deg. C

Mean variation of the consumed power with respect to the input voltage.

Table 3.4.2-l : Power Consumption Data Sheet

AVHRR/3

dP/dV @ 25 deg. C **Typ. 0.23 W/V**

Instr. Mode	Power Bus	Typical Beginning of Life (W) Mean Power	Min. Power	Max. Power	Peak Power	Peak Duration	Peak Duty Cycle	Worst Case End of Life (W) Mean Power	Min. Power	Max. Power	Peak Power	Peak Duration	Peak Duty Cycle	Failure Power
Off Mode (a)	28 V Main Bus	**9.26**			**None**	**None**		**9.60**			**None**	**None**		
	10 V Interface Bus	0.04						0.05						
	TOTAL	*9 .*	*3 0*		*None*	*None*		*9.65*			*None*	*None*		*N/A*
Heater / Outgas Mode (b)	28 V Main Bus	33.13	21.61	44.64	None	None		**34.78**	22.68	46.87	None	None		
	10 V Interface Bus	00.04	00.04	00.04				00.05	00.05	00.05				
	TOTAL	***33.17***	*21.65*	*44.68*	*None*	*None*		*34.83*	*22.73*	*46.92*	*None*	*None*		*N/A*
Measurement Mode	28 V Main Bus	25.84			82.74	1 sec.	Once	**26.95**			None	None		-
	10 V Interface Bus	00.04			00.04	(c)		00.05			(d)	.		
	TOTAL	*25.88*			*82.78*			27.00			*None*	*None*		*N/A*

(a) **Off Mode** : Motor / **Telemetry** On **(See** § 1.4. and 1.3.).

(b) Heater **/ Outgas** Mode : Motor, Telemetry, Electronics, Cooler Heaters, Channels 1.2 and 3A ON (See **§1.4.** and **1.5.**).

(c) Peak power adds Earth shield deploy power (56.9 **W)** to BOL mean measurement mode power. *)

(d) There is no peak power during measurement mode **at** EOL : the door is already released.

The cooler outgas heater power with the door closed (first heater mode) cycles at about 10 to 20% duty cycle whereas, with door open (subsequent heater modes) it cycles at 95% duty cycle

3.43. Power Electrical Interface Requirements

In order to structure the electrical interfaces, all signals to be controlled by this document will be identified and classified into a certain number of signal types. For each signal type a three character identifier code is given as defined in the corresponding tables. In most cases the power-signal code is identical to the code'of the Data Sheet by which the signal is specified.

Table 3.4.3-l shows the power interface types used by the AVHRR/3 and the corresponding data sheet identifiers.

	Data Sheet Code	Interface Circuit
+28 V Main Power Bus	APB	Fig. **3.4.3.2- 1**
+28 V Motor Power Bus	APB	Fig. **3.4.3.2-2**
+10 V Interface Bus	DPB	Fig. 3.4.3.2-3

Table* 3.4.3-I *: Power Interfaces to AVHRR/3

Within the Power Interface Data Sheets, the electrical characteristics of the power interfaces are defined.

3.4.3.1. Power Interface Data Sheets

On the following pages, the electrical characteristics of the power interfaces are defined with one Data Sheet per signal. In Table 3.4.3-l :'AVHRR/3 Power Interfaces' and § 3.4.5 Pin 'Allocation' is referenced to these Data Sheets.

The performances specified in the Data Sheets are maintained during the mission lifetime and under nominal load and temperature range conditions. Source specifications have to be measured at the connector of the source and load specifications have to be measured at the connector of the load unless specified otherwise.

*Parameter **Definitions***

***Small** Signal Impedance*
Output impedance of the power supply tested with, compared to 28V, small AC signals.

Output *Impedance*
Linear output impedance of the power supply.

Voltage Ripple
Sinusoidal voltage ripple, including repetitive spikes and voltage drop caused by the instruments current ripple.

Under-Voltage (incl. ripple & trans.)
The *specified* voltage range will be considered as under-voltage.

Over-Voltage (incl. ripple & trans.)

The *specified* voltage range will be considered as over-voltage.

Transients

Positive or negative going, non repetitive spikes caused by load current changes.

Max Steady-State Current

Maximum power as defined in the Power Consumption Data Sheet divided by the minimum specified nominal voltage.

Current Ripple

Ripple caused by the load pulsed currents (DC/DC converter, stepper motors...).

Inrush Current

Maximum allowed input current for a restricted time, when the load is switched on.

Inrush Current Rate

Rate-of-change of the input current over time when the load is switched ‘on’.

Signal Nomenclature	28 V Main Power Bus	
Code	APB	
EMC Class	Power	
Power Source Specification		
Parameter	Requirement	**Remarks**
Voltage	27.16 . . . 28.84 V	at AVHRR/3 input
Small Signal Impedance	< 0.3 Ω	f< 100 kHz, short circuit protection & line < 0.1Ω
Voltage Ripple	See § 4.3.1.2.	
Under-Voltage (incl. ripple & trans.)	> 16.00 V ; < 27.16 V	for < 3 s
Over-Voltage (incl. ripple & trans.)	> 28.84 V ; < 38.00 V	for < 50 ms
Transients	See § 4.3.1.2.	
Max. Current	< 5.0 A	Limited by short circuit protection
Leakage Current	< 6 mA	Short circuit protection 'Off'
Load Specification		
	Requirement	**Remarks**
Max. Steady-State Current	2 A	
Current Ripple	< 2% Max Steady-State cllrr. <(40 mA)	f < 100 kHz
Inrush Current	< 3.3 A_{op}	Steady- State after 30 ms. 1s for motor start-up and cooler door opening
Inrush Current Rate	< 30 mA/µs	
Accepted Voltage Range	26 . . . 30 V	
Accepted Under-Voltage	> 16.00 V ; < 26.00 V	for < 3 s
Accepted Over-Voltage	> 30.00 V ; < 38.00 V	continuous
Accepted Transients	-12 V ... + 10 V (tbc)	Duration< 10 µs
Harness Design		
Parameter	Requirement	**Remarks**
Wiring Type	AWG 20, T4	

Signal Nomenclature	**+10 V Interface Bus**	
Code	**DPB**	
EMC Class	Power	
Power Source Specification		
Parameter	**Requirement**	**Remarks**
Voltage	9.5 . . . 10.5 v	at **AVHRR/3 input**
Source Current	**< 100 mA**	
Small Signal Impedance	**< 1 Ω**	**f < 10 MHz**
Voltage Ripple	See § 4.3.1.2.	
Under-Voltage (incl. ripple & trans.)	> 9.0 v ; < 9.5 v	
Over-Voltage (incl. ripple & trans.)	> 10.5 v ; < 15 v	
Voltage Transients	See § 4.3.1.2.	
had Specification		
Parameter	**Requirement**	Remarks
Max. Steady-State Current	7.5 **mA**	
Current Ripple	**< 5 mA**	f < 2.5 MHz
Inrush Current	< 125% Max Steady-State **Curr.** (9.4 **mA)**	for < 60 ms
Inrush Current Peak	**< 50 mA**	for < 0.5 ms
Harness Design		
Parameter	**Requirement**	Remarks
Wiring Type	AWG 24, TP	

3.4.3.2. Power Interface Circuits

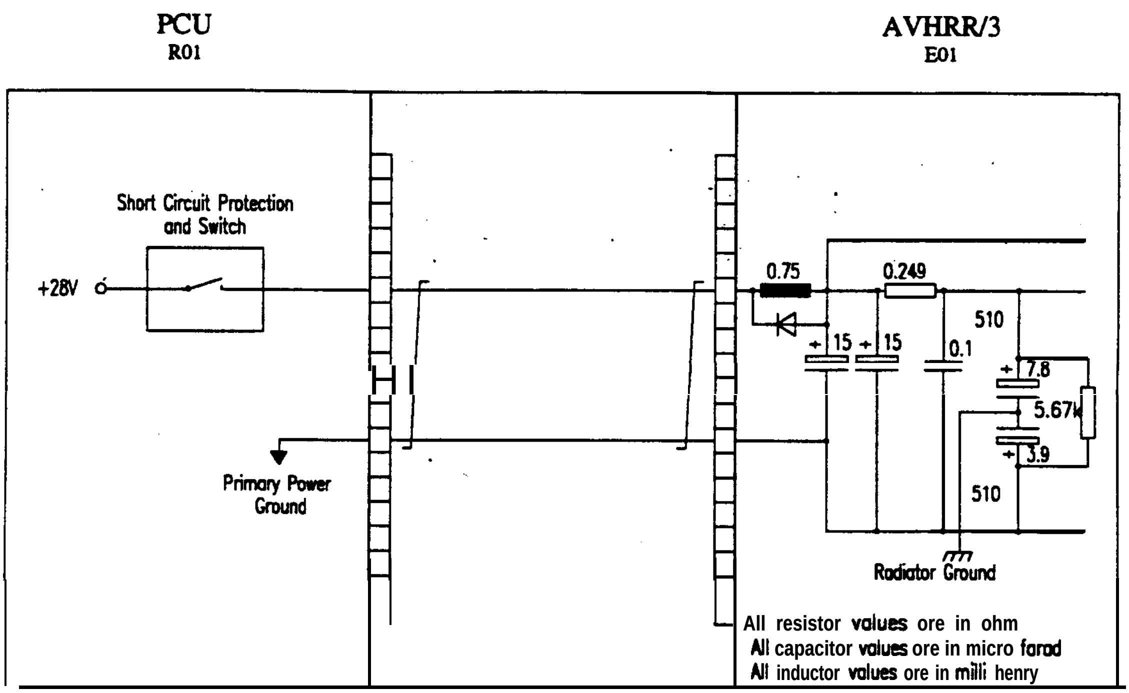


Figure 3.4.3.2-1: +28 V Main Power Bus Interface Circuit

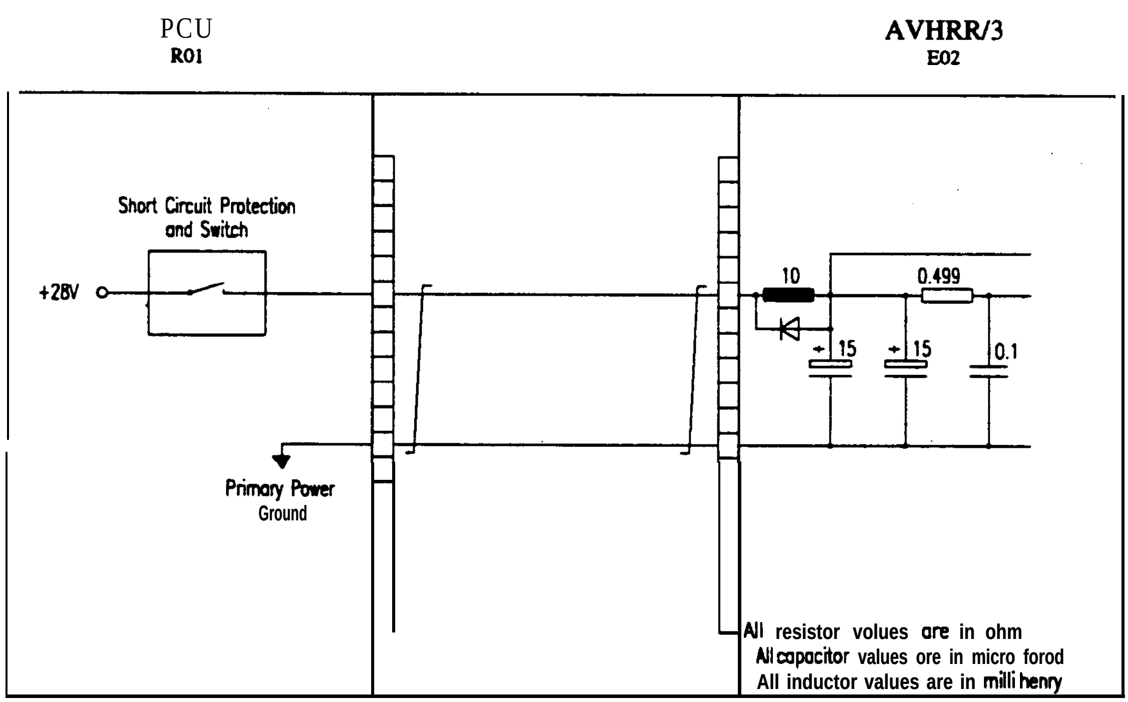


Figure 3.4.3.2-2 : +28 V Motor Power Bus Interface Circuit

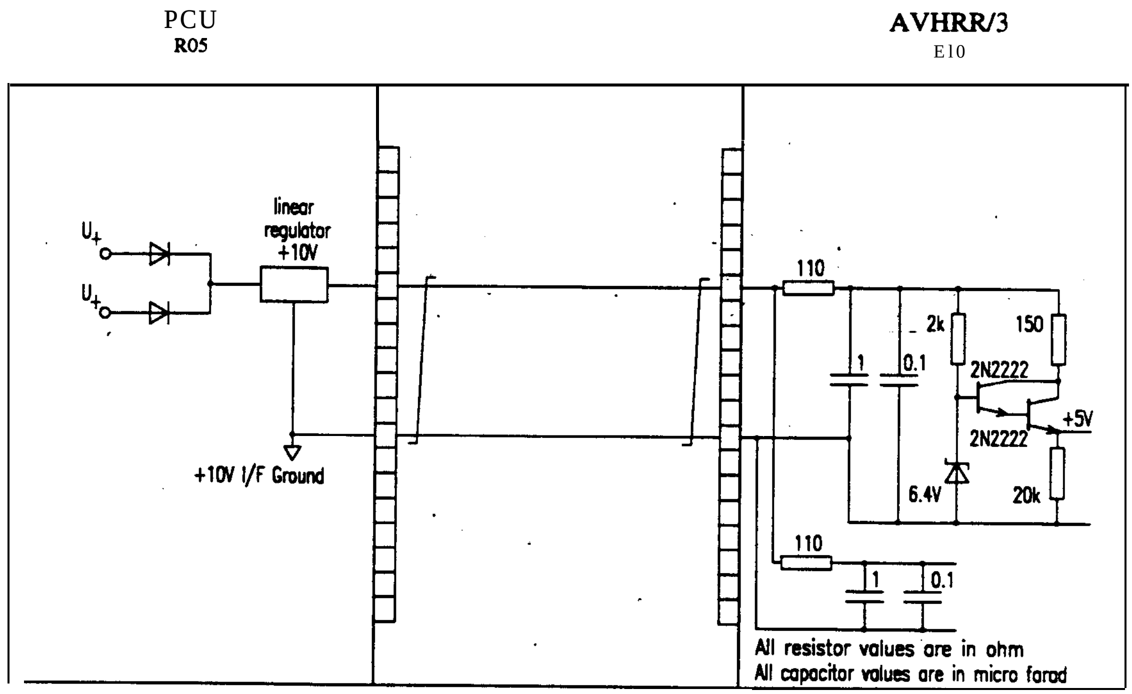


Figure 3.4.3.2-3 : +10 V Interface Bus Interface Circuit

3.4.4. Power Connectors

Table 3.4.4-1 identifies the power connector types at the AVHRR/3 boxes and Table 3.4.4-2 identifies the power connector types at the AVHRR/3 harness.

There is no dedicated connector on the instrument used on METOP for the thermal control of the baseplate.

Connector	Connector-Type	Function
JO3	TD1B25LP *)	Power
J33	TD1E9LS *)	Heater TCU I/F (TIROS specific)

*) ITT-Cannon filter pin connector

Table 3.4.4-1: Power Connector Types at AVHRR/3 Boxes

Connector	Connector-Type	Function
PO3	DBMA-25S-NMB	Power
P33	DEMA-9P-NMB	Not used at METOP level

Table 3.4.4-2: Power Connector Types at AVHRR/3 Harness

3.4.5. Power Pin Allocation Lists

In these lists, the cross reference between connector pin, signal designation, Interface Data Sheet, target connector and target connector pin is defined and recorded as data base. Per connector one list is prepared.

Interface Data Sheets can be found in § 3.4.3.1.

The individual pin allocation lists are specified by the 9 characters of the alpha numerical connector number. For the AVHRR/3 the first 3 characters are AVH. The 7th character is J for a box connector or P for a harness connector. The last two characters define the connector number.

Since these lists also specify the wiring and shielding, they also form the basis for harness manufacturing.

The power connector pin allocations at instrument level are described in Tables 3.4.5/1 and /2. The power connector harness are described in Tables 3.4.5/3 and /4.

Connector : 1AVH305J03 Item : AVHRR/3 Function : Power **Backshell :** N/A
EMC-Category : 1 **Conn.-Type** : TD1B25LP

Pin	Signal Designation		Interface-Code Circ	Signal	Pos.	Grouping Ch. ID	Shd	Cable	Twist	Comment	New
01	+28V Main PwrBus AVH	.SUP1	E01	APB-	- D	AB00				Pin 1 and Pin 2	
05	+28V Main PwrBus AVH	.RTN1	E01	APB-	- 7	AB00				Pin 5 and Pin 6	
'02	+28V Main PwrBus AVH	.SUP2	E01		- D					are shorted each at	
06	+28V Main PwrBus AVH	.RTN2	M1'		- 7					he J-Connector	
03	+28V Main PwrBus AVH	.SUP3	E02	APB-	- D	AB00				Pin 3 and Pin 4	
07	+28V Main PwrBus AVH	.RTN3	E02	APB-	- 7	AB00				Pin 7 and Pin 8	
04	+28V Main PwrBus AVH	.SUP4	E02		- D					are shorted each at	
08	+28V Main PwrBus AVH	.RTN4	E02		- 7					he J-Connector	
09	+10V I/F Bus AVH	.SUP1	El0	DPB-	- D	DBOO ,				Pin 9 and 10	
13	+10V I/F Bus AVH	.RTN1	El0	DPB-	- 7	DBOO				Pin 13 and 14	
10	+10V I/F Bus AVH	.SUP2	E10		- D					are shorted each at	
14	+10V I/F Bus AVH	RTN2	E10		- 7					the J-Connector	
15	Signal GND PO3 AVH	.GND		GND-	-	GD09				Pin 15 and 16	
16	Signal GND AVHRRP3	.GND		GND-	-	GD10				Pin 17 and 18	
17	Chassis Gnd AVH	.-								are shorted each at	
18	Chassis Gnd AVH	.-								he J-Connector	
11	spare	.-									
12	Spare	.-									
19	Spare	.-									
20	Spare	.-									
21	Spare	.-									
22	Spare	.-									
23	Spare	.-									
24	Spare	.-									
25	Spare	.-									

Table 3.4.5/1 : Fin Allocation List of Connector JO3

Not used at METOP level

Table 3.4.5/2 : Pin Allocation List of Connector J33

Connector : 1AVH305P03 Ittm : AVHRR/3 Function : Power Conn.-Type : DBMA-25S-NMB
EMC-Category : 1 Location : 305 Backshell : T B D

			Interface-Code			Grouping											
Pin	Signal Designation		Circ	Signal	Pa.	Cb. ID	Wiring	Shd	Cable	Twist	Comment	End-It.	Loc.	Connector	Pin	New
01	+28V Main PwrBus AVH	.SUP1	E01	APB- -	D	AB00	T4-20				Pin I and Pin 2	PCU	230	PCU230 Pxx		
05	+28V Main PwrBus AVH	.RTN1	E01	APB- -	7	AB00	T4-20				Pin 5 and Pin 6	PCU	230	PCU230 Pxx		
02	+28V Main PwrBus AVH	.SUP2	E01	-	D						are shorted each at					
06	+28V Main PwrBus AVH	.RTN2	E01	-	7						the J-Connector					
03	+28V Main PwrBus AVH	.SUP3	E02	APB- -	D	AB00	T4-20				Pin 3 and Pin 4	PCU	230	PCU230 Pxx		
07	+28V Main PwrBus AVH	.RTN3	E02	APB- -	7	AB00	T4-20				Pin 7 and Pin 8	PCU	230	PCU230 Pxx		
04	+28V Main PwrBus AVH	.SUP4	E02	-	D						are shorted each at					
08	+28V Main PwrBus AVH	.RTN4	E02	-	7						the J-Connector					
09	+10V I/F Bus AVH	.SUP1	E10	DPB- -	D	DB00	TP-24				Pin 9 and IO	NIU	240	NIU240 Pxx		
13	+10V I/F Bus AVH	.RTN1	E10	DPB- -	7	DB00	TP-24				Pin 13 and 14	NIU	240	NIU240 Pxx		
IO	+10V I/F Bus AVH	.SUP2	E10	-	D						are shorted each at					
14	10V I/F Bus AVH	.RTN2	E10	-	7						the J-Connector					
15	Signal GND PO3 AVH	.GND		GND- -		GD09	SL-20				Pin 15 and 16	NIU	240	NIU240 Pxx		
16	Signal GND AVHRRP3	.GND		GND- -		GD10	SL-20				Pin 17 and 18	NIU	240	NIU240 Pxx		
17	Chassis Gnd AVH										are shorted each at					
18	Chassis Gnd AVH										the J-Connector					
11	Spare	.-														
12	Spare															
19	Spare	.-														
20	Spare															
21	Spare	.-														
22	Spare															
23	Spare	.-														
24	Spare															
25	Spare	.-														

Table 3.4.5/3 : Pin Allocation List of Connector PO3
(For Information Only)

Not used at **METOP** level

Table 3.4.5/4 : Pin Allocation List of Connector P33
(For Information Only)

3.5. SIGNAL ELECTRICAL INTERFACES

35.1. Overview

An overview on the signal electrical interfaces between PLM and the AVHRR/3 is presented in Figure 35.1-1.

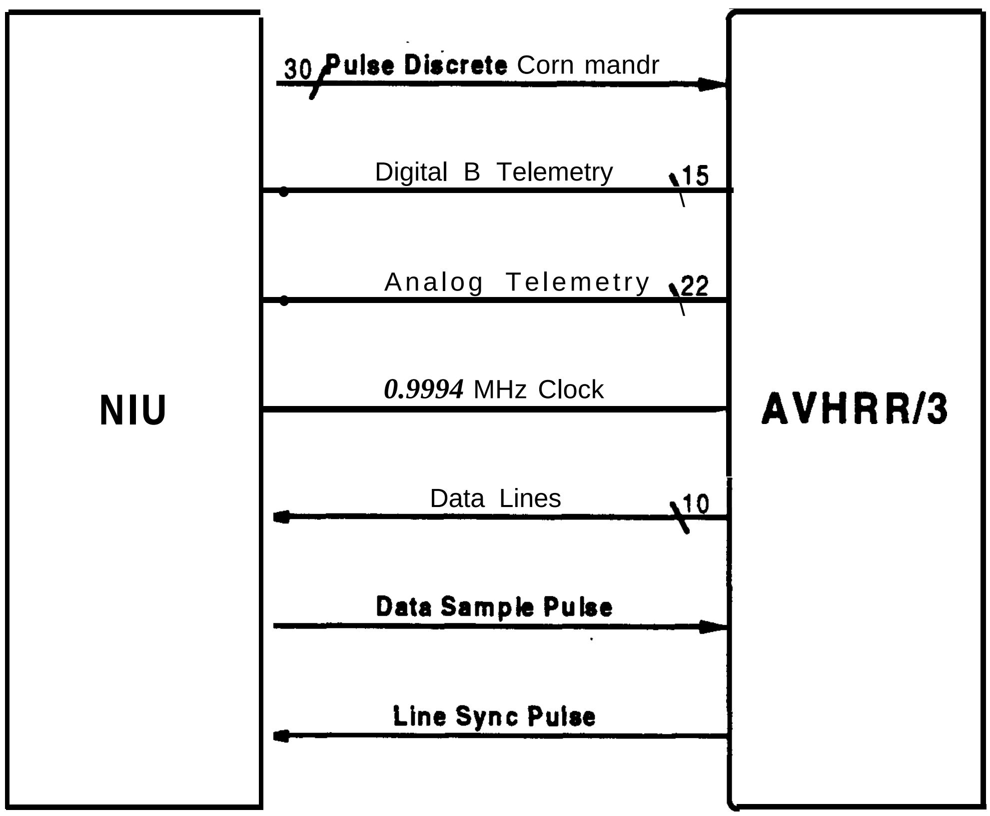


Fig. 3.5.1-I : Signal Electrical Interfaces PLM ⇔ AVHRR/3

3.5.2. Signal Electrical Interface Requirements

Table 3.5.2-l lists all signals of the **AVHRR/3** signal **electrical** interfaces and gives references to the Interface Data Sheets in § 3.5.2.1 as well as the interface circuits in § 3.5.2.2.

Table 3.5.2-l : ***Signal to Data Sheets & Interface Circuits Assignments (1/3)***

Signal	Data Sheet Code	Interface circuit	- Remarks
Elec/Telemetry On **AVHRR/3** **Elec/Telemetry** Off **AVHRR/3** Earth Shield Disable **AVHRR/3** Earth Shield Deploy **AVHRR/3** **Motor/Telemetry** On **AVHRR/3** **Motor/Telemetry** Off **AVHRR/3** Telemeuy Not Locked On **AVHRR/3** Telemetry Locked On **AVHRR/3** Channel 1 Enable **AVHRR/3** Channel 1 Disable **AVHRR/3** Channel 2 Enable **AVHRR/3** Channel 2 Disable **AVHRR/3** Channel 3A Enable **AVHRR/3** Channel 3A Disable **AVHRR/3** **Channel** 3B Enable **AVHRR/3** Channel 3B Disable **AVHRR/3** Channel 4 Enable **AVHRR/3** Channel 4 Disable **AVHRR/3** Channel 5 Enable **AVHRR/3** **Channel** 5 Disable **AVHRR/3** Channel 3A Select **AVHRR/3** Channel 3B Select **AVHRR/3** Scan Motor **Low** **AVHRR/3** Scan Motor High **AVHRR/3** Patch Control Off **AVHRR/3** Patch Control On **AVHRR/3** Cooler Heater On **AVHRR/3** Cooler Heater Off **AVHRR/3** Voltage Calibrate On **AVHRR/3** Voltage Calibrate Off **AVHRR/3**	**CCP**	Fig. 3.5.2.2-l	Pulse Discrete commands

Table 3.5.2-I : Signal to Data Sheets & Interface Circuits Assignments (2/3)

Signal	Data Sheet Code	Interface circuit	Remarks
Earth Shield Status TLM AVHRR/3 Patch Control Status TLM AVHRR/3 Scan Motor Mode Status TLM AVHRR/3 Voltage Calibrate Status TLM AVHRR/3 Cooler Heat Status TLM AVHRR/3 Electr./TLM Status TLM AVHRR/3 Motor/TLM Status TLM AVHRR/3 TLM Lock Status TLM AVHRR/3 Channel 1 Status TLM AVHRR/3 Channel 2 Status TLM AVHRR/3 Channel 3A Status TLM AVHRR/3 Channel 3B Status TLM AVHRR/3 Channel 4 Status TLM AVHRR/3 Channel 5 Status TLM AVHRR/3 Chan. 3A/3B Output Select TLM AVHRR/3	TLD	Fig. 3.5.2.2-2	Digital B HK Telemeuy
Radiator Temp. AVHRR/3 Low Range Patch Temp. AVHRR/3 TM Ext. Range Patch Temp. AVHRR/3 Blackbody #1 Temp. AVHRR/3 Blackbody #2 Temp. AVHRR/3 Blackbody #3 Temp. AVHRR/3 Blackbody #4 Temp. AVHRR/3 Electronics Temp. AVHRR/3 Base Plate Temp. AVHRR/3 A/D Converter Temp. AVHRR/3 Motor Housing Temp. AVHRR/3 Cooler Housing Temp. AVHRR/3 IR Ch. 3B BB Temp. AVHRR/3 IR Ch. 4 BB Temp. AVHRR/3 IR Ch. 5 BB Temp. AVHRR/3 Patch Power AVHRR/3 Motor Current (DC) AVHRR/3 Electr. Current AVHRR/3	TLA	Fig. 3.5.2.2-3	Analog HK Telemetry
Earth Shield Position AVHRR/3		Fig. 3.5.2.2-4	
Detector Bias Volt Ch. 4 AVHRR/3 Detector Bias Volt Ch. 5 AVHRR/3		Fig. 3.5.2.2-5	
Reference Voltage AVHRR/3		Fig. 3.5.2.2-6	

Table 3.5.2-I : ***Signal to Data Sheets & Interface Circuits Assignments (3/3)***

Signal	Data Sheet Code	Interface Circuit	Remarks
'0.9984 MHz Clock AVHRR/3	CLS	Fig. 3.5.2.2-7	liming : see § 3.3
Data Line 2^0 AVHRR/3 Data Line 2^1 AVHRR/3 Data Line 2^2 AVHRR/3 Data Line 2^3 AVHRR/3 Data Line 2^4 AVHRR/3 Data Line 2^5 AVHRR/3 Data Line 2^6 AVHRR/3 Data Line 2^7 AVHRR/3 Data Line 2^8 AVHRR/3 Data Line 29 AVHRR/3	DOV	Fig. 3.5.2.2-8	liming : see § 3.3
Data Sample Pulse AVHRR/3	DEV	Fig. 3.5.2.2-9	
Line Sync. Pulse AVHRR/3	LSY	Fin. 3.5.2.2-10	

3.5.2.1. Signal **Electrical Interface Data Sheets**

On the following pages the electrical characteristics of the signal electrical interfaces are defined with one Data Sheet per signal. In § 3.5.2 'Signal Electrical Interface Requirements' and § 3.5.4 'Signal Pin Allocation' is referenced to these Data Sheets.

The performances specified in the Data Sheets are maintained during the mission lifetime and under nominal load and temperature range conditions. Source specifications have to be measured at the connector of the source and load specifications have to be measured at the connector of the load unless specified otherwise.

The Fault Voltage Protection is the maximum **externally** induced voltage that the specified input or output can withstand without damage. The Fault Voltage Emissions is the maximum internally generated voltage that the specified input or output can create under worst case fault conditions.

Signal Nomenclature	Pulse Discrete Commands (Short)	
Code	**CCP**	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	Remarks'
'1' - Level / 'TRUE'	-0.2 ... +0.2 v	line to 10 V f/F-ground
'0' - Level / FALSE' (V_{OH})	+9.3 . . . +10.7 v	**line to 10 V I/F ground**
Rise Time 10% to 90%:	**< 12 µs**	cable length < 5 m
Fall Time 90% to 10%	**< 12 µs**	cable length c 5 m
Pulse Duration	**60 ms ± 5 ms**	'1' - Level
Output Impedance	< 1.5 kΩ	R (CMOS output) + 200 Ω
Source Current	**> 1 mA**	@ V_{OH} = 9.5 v
Fault Voltage Emissions	0 V . . . V_{DD}	**R_S > 100 Ω**
Fault Voltage **Protection**	-0.5 V . . . V_{DD} + 0.5 V	V_{DD} see Note
Load Circuit **Specification**		
Parameter	Requirement	Remarks
'1' - Level / 'TRUE'	-0.5 . . . +2 v	line to 10 V I/F ground
'0' - Level / 'FALSE	+8.0 . . . +10.8 V	**line to 10 V I/F ground**
Sink Current	**< 1 mA**	
Input Impedance	**> 90 kΩ**	
Fault Voltage Emissions	0 V . . . V_{DD}	**R_S > 2 kΩ**
Fault Voltage Protection	-0.5 V . . . V_{DD} + 0.5 V	V_{DD} see Note
Accepted Rise / Fall Time	**< 15 µs**	**10 % to 90 %**
Harness Design		
Parameter	Requirement	**Remarks**
Wiring Type	AWG 24, single line	return via + 10 V I/F ground

Note : V_{DD} is the common supply voltage for the source and the load circuit.
Definition of V_{DD} : see Data Sheet '+ 10 V Interface Bus - DPB' in § 3.4.3.1.

Signal Nomenclature	Digital B Telemetry	
Code	TLD	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.1 ... +0.5 V	Ground reference
'0' - Level	+3.5 ... +5.7 V	See interface circuit
Spectral Frequency Range	0 ... 200 Hz	for f > 200 Hz filter required ; sampling rate see under Load
Output Impedance	2 kΩ ... 15 kΩ	
Source Current	> 60 µA	
Fault Voltage Emissions	TBD_{AVH}	TBD_{AVH}
Fault Voltage Protection	-15 ... +15 V	R_S > 0.2 kΩ
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	-0.2 ... +0.8 V	line to 10 V I/F ground
'0' - Level	+3.0 ... +5.7 V	line to 10 V I/F ground
Sink Current	< 60 µA	
Sampling Rate	0.125 ... 16 s	
Fault Voltage Emissions	-15 ... +15 V	R_S > 0.2 kΩ
Fault Voltage Protection	-15 ... +15 V	
Input Impedance	>100 kΩ	
Harness Design:		
Parameter	Requirement	Remarks
Wiring Type	AWG 24, single line	return via 10 V IF ground

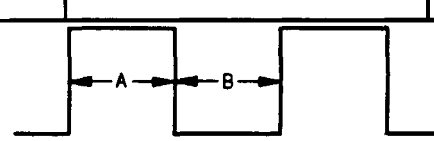
Signal Nomenclature	Analog HK Telemetry	
Code	TLA	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
Voltage Range	0 ... 5.12 v	load > 2 MΩ
Spectral Frequency Range	0 . . . 200 Hz	for f > 200 Hz filter required ; sampling rate see under Load
Output Impedance	2 kΩ . . . 15 kΩ	
source current	> 3 µA	
Fault Voltage Emissions	TBD_{AVH}	TBD_{AVH}
Fault Voltage Protection	-15 . . . +15 v	$R_S > 2$ kΩ
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
Input Voltage Range	0 ... 5.12 V	Line to return
Sampling Rate	0.125 . . . 16 s	
Conversion Resolution	8 bit	20 mV/LSB
Measurement Accuracy	20 mV	
Sink Current	< 3 µA	
Fault Voltage Emissions	-15 . . . +15 V	$R_S > 2$ kΩ
Fault Voltage Protection	-15 . . . +15 v	
Input Impedance	> 2 MΩ	
Harness Design		
Parameter	Requirement	Remarks
Wiring Type	AWG 24, Single Line	Return via Signal Ground

Signal Nomenclature	**0.9984 MHz Clock**	
Code	**CLS**	
EMC Class	RF	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
Low Level Output **Current**	0.0 ... **0.1 mA**	**each line terminated**
High Level Output Current	1.6 . . . 5.4 **mA**	**with 50 Ω ± 10 Ω to ground**
Frequency	**0.9984** MHz **± 1.10**$^{-6}$ initial setting	square wave
Stability	**5.10**$^{-9}$ **/ sec**	
Frequency Drift	**5.10**$^{-6}$ **/** week 1.10^{-6} **/** year	Over temperature range at **constant temperature**
Rise **/** Fall **Time** 10% to **90%**	**< 60 ns**	cable length **<** 5 m **terminated with 2 x 50 Ω**
Clock Symmetry	> 67 **%**	see figure below
Source Current	**> 6 mA**	**per line**
Fault Voltage Emissions	0 . . . + 6 V	
Fault Voltage **Protection**	-0.5 v . . . + 5 v	
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
Low Level	-3.0 . . . -0.03 v	**line to line**
High Level (V_{IH})	**+0.03** . . . **+3.0** v	linetoline
Sink Current	**<** 5.4 **mA**	per line **@** V_{IH} = 0.32 V
Input Impedance	**2 x 51 Ω ± 5 Ω** **10 kΩ**	Line to **line** **Line** to ground
Fault Voltage Emissions	**TBD**$_{AVH}$	
Fault Voltage Protection	**TBD**$_{AVH}$	
Accepted Rise **/** Fall Time 10% to 90%	**< 260 ns**	cable length **<** 5 m **terminated with 2 x 50 Ω**
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	2 coax cables, 50 **Ω**	

Symmetry

A / B x 100 % if B > A

B/Ax 100% **if A > B**



Signal Nomenclature	**Data Line AVHRR/3**	
Code	DOV	
EMC Class	Signal	
Source **Circuit Specification**		
Parameter	**Requirement**	**Remarks**
'1' - Level	**+2.4 ... +5.25** v	**line to signal ground**
'0' **-** Level	-0.2 . . . **+0.4** v	**line to signal ground**
Data Word Rate (Burst)	199 680 words **/** s	**During data transmission**
Rise Time 10% to 90%	**< 60 ns**	cable **length <** 5 m
Fall **Time** 90% to 10%	**< 60 ns**	cable length **<** 5 m
Output Impedance	**<** 120n	**TTL** buffer output
Source Current	**>** 1.2 **mA**	output high
	> 48 mA	output low
Fault Voltage Emissions	**TBD**$_{AVH}$	
Fault Voltage Protection	**TBD**$_{AVH}$	**R_S > 600 Ω**
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	**+2 . . . +5.25** v	linetosignalground
'0' - Level	-0.2 . . . **+0.8** V	line **to** signal ground
Sink Current	< **10 mA**	input low
	< 1 mA	input high
Input Impedance	**> 600 Ω**	
Fault **Voltage Emissions**	0 ... + **TBD**$_{MET}$ V	**R_S > 600 Ω**
Fault Voltage Protection	**-15 . . . + 15** v	
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24, shielded see Fig. 3.5.2.2-8	return via signal ground

Signal Nomenclature	Data Sample Pulse AVHRR/3	
Code	DEV	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level (V_{OH})	+2.4 . . . +5.25 v	line to signal ground
'0' - Level	-0.2 . . . +0.4 v	line to signal ground
Repetition Rate During Data Transmission	39.936 kpps	Tolerance depends on 0.9984 MHz clock
Stability	Derived from 0.9984 MHz Clock	See Data Sheet CLS
Pulse Width	1.002 µs ± 10 %	at '1' - Level ; phased so that the negative edge of the 0.9954 MHz clock occurs at the middle of the sample pulse
Rise Time 10% to 90%	< 60 ns	cable length c 5 m
Fall Time 90% to 10%	< 60 ns	cable length < 5 m
Output Impedance	< 700 Ω	R/2 (CMOS output)
Source Current	> 2 mA	@ V_{OH} = 4.6 V
Fault Voltage Emissions	0 V ... TBD_{MET} V	
Fault Voltage Protection	-0.5 v . . . 5.0 v	
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	+2 ... +5.25 v	line to signal ground
'0' - Level	-0.2 . . . +0.8 V	line to signal ground
Sink Current	< 1.6 mA	input low
	< 40 µA	input high
Fault Voltage Emissions	TBD_{AVH}	
Fault Voltage Protection	TBD_{AVH}	
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24, shielded	Return to signal ground

Signal Nomenclature	Line Synchronization Pulse	
Code	LSY	
EMC Class	Signal	
Source Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	+2.4 . . . +5.25 V	line to signal ground
'0' - Level	-0.2 . . . +0.4 v	line to signal ground
Repetition Rate	6 pps	tolerance depends on 0.9984 MHz clock and line-line jitter
Pulse Width	100 µs ± 2 µs	at '1' - Level ; leasing edge = line sync.
Rise Time 10% to 90%	< 60 ns	cable length < 5 m
Fall Time 90% to 10%	< 60 ns	cable length < 5 m
Output Impedance	c 120R	TTL buffer output
Source Current	> 1.2 mA	output high
	> 48 mA	output low
Spikes	< 0.6 V_{pp}	@ '1' - Level:
	< 0.1 V_{pp}	@ '0' - Level:
Scan Line to Scan Line Jitter (within 20 minute period)	< ± 17.2 µs	98 % of measurements
Fault Voltage Emissions	0 . . . + TBD_{AVH} V	
Fault Voltage Protection	0 . . . + TBD_{AVH} V	R_S > 600 Ω
Load Circuit Specification		
Parameter	**Requirement**	**Remarks**
'1' - Level	+2 . . . +5.25 v	line to signal ground
'0' - Level	-0.2 . . . +0.8 V	line to signal ground
Sink Current	< 10 mA	input low
	< 1 mA	input high
Input Impedance	> 600 Ω	
Fault Voltage Emissions	0 ... + TBD_{MET} V	R_S > 600 Ω
Fault Voltage Protection	-15 . . . + 15 v	
Harness Design		
Parameter	**Requirement**	**Remarks**
Wiring Type	AWG 24, shielded	return via signal ground

35.2.2. Signal Interface Circuits

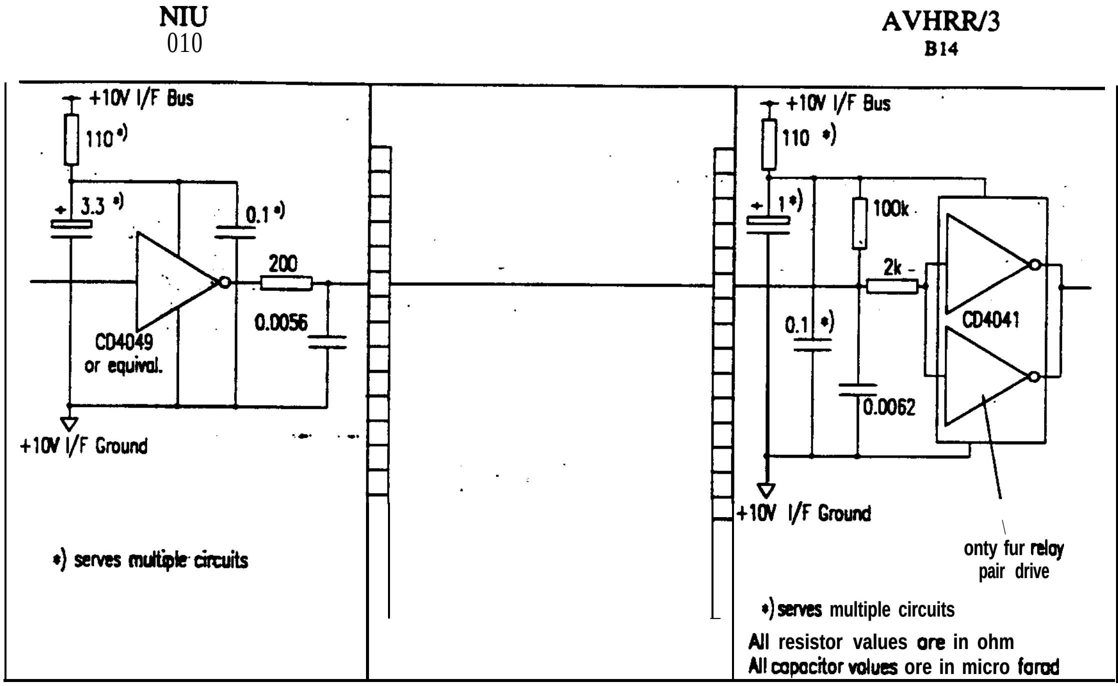


*Fig. 3.5.2.2-I : **AVHRR/3** Command Receiver For **Relay** Drive Interface* Circuit

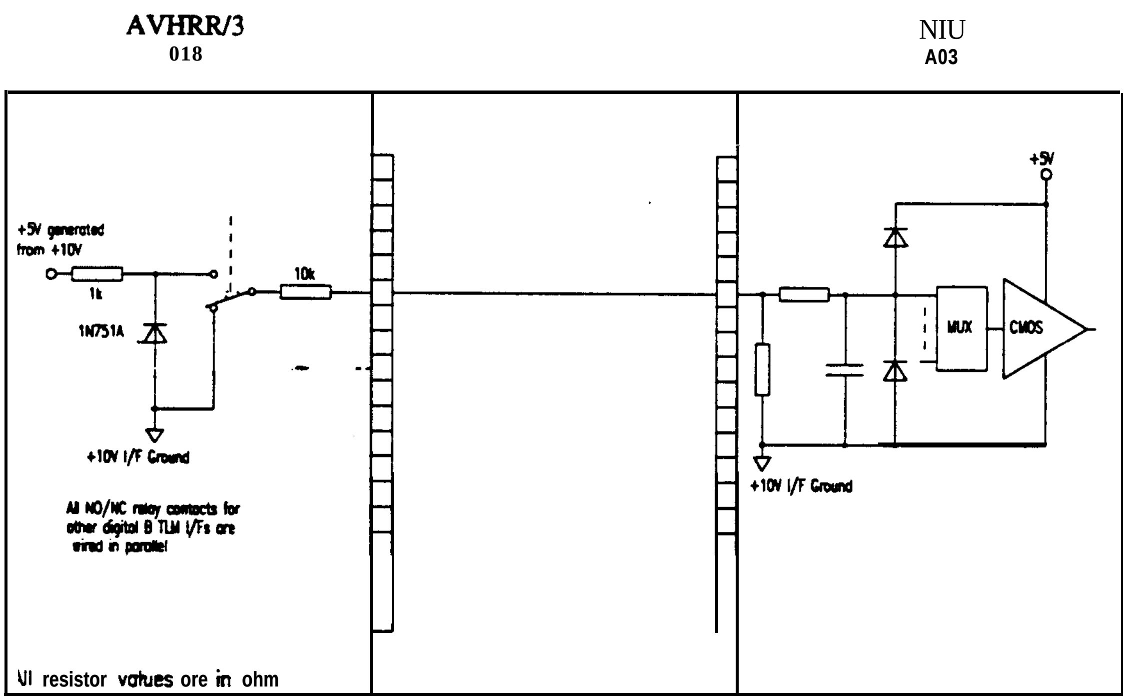
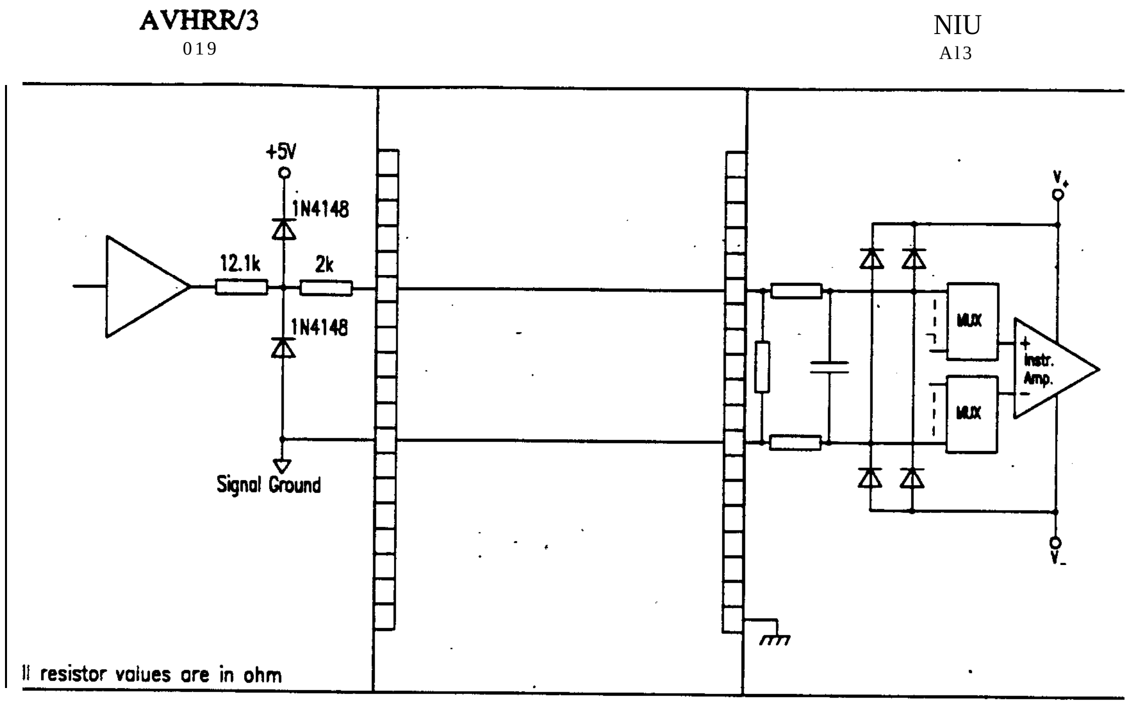
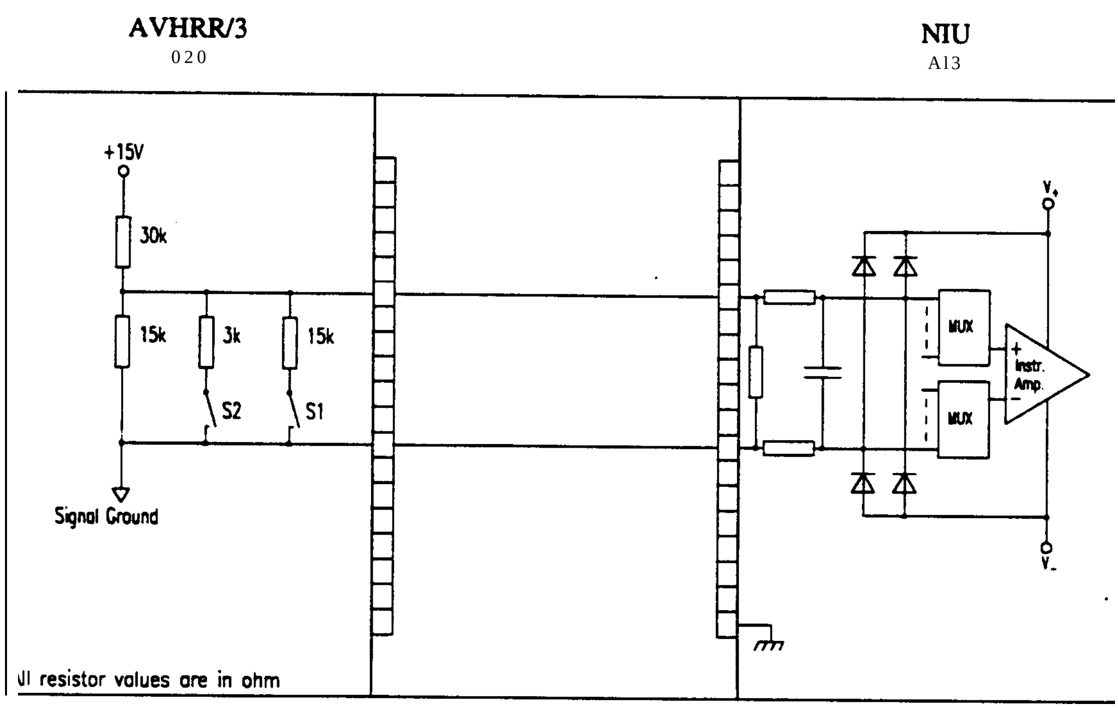


Fig. 3.5.2.2-2 : AVHRR/3 *Digital B **Telemetry Interface** Circuit*



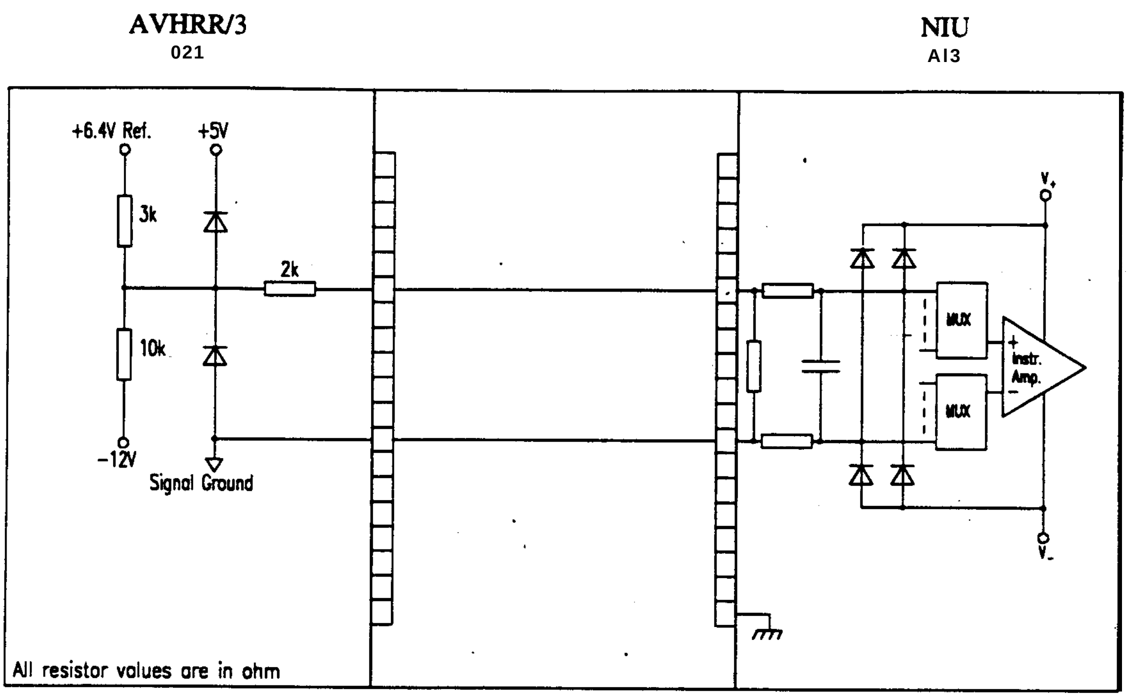
Remark : Only one Signal Ground line is provided from AVHRR/3 for all interfaces.

*Fig. 3.5.2.2-J : **AVHRR/3 Typical Analog** Telemetry **Interface** Circuit*



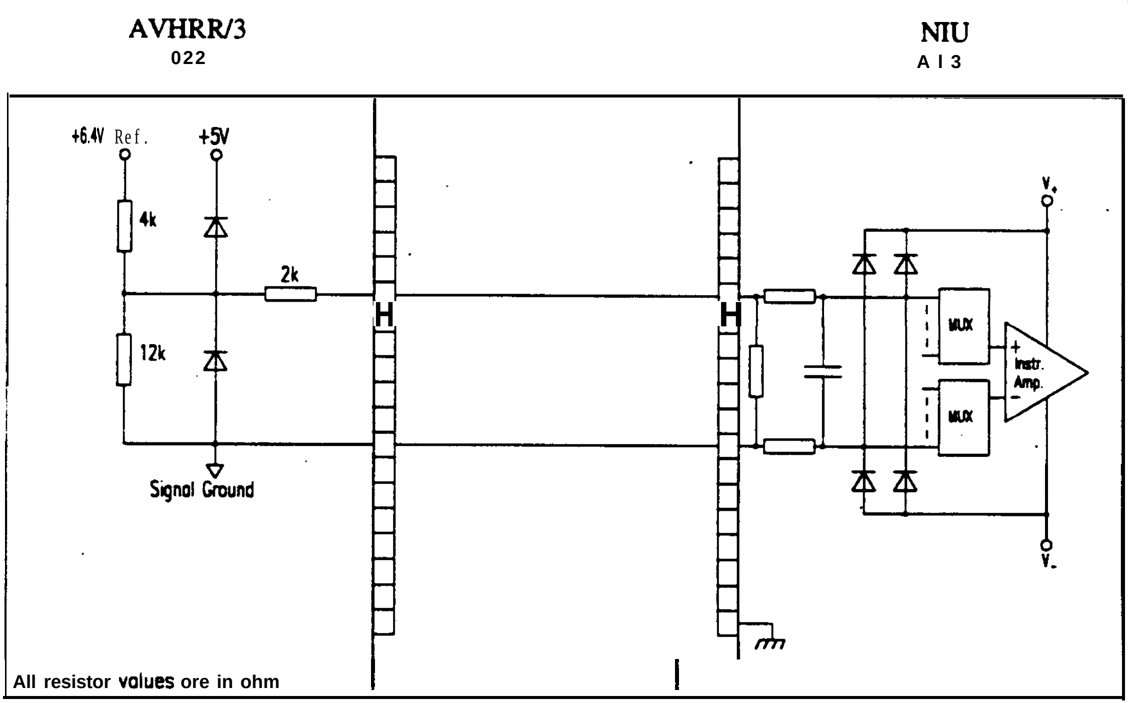
Remark : Only one Signal Ground line is provided from AVHRR/3 for all interfaces.

*Fig. 3.5.2.24 : **AVHRR/3** Earth Shield Position **Analog Interface** Circuit*



Remark : Only one Signal Ground line is provided from AVHRR/3 for all interfaces.

Fig. 3.5.2.2-S : A VHRR/3 Channel 4/5 Detector Bias Analog Telemetry Interface Circuit



Remark : Only one Signal Ground line is provided from AVHRR/3 for all interfaces.

Fig. 3.5.2.2-6 : A VHRR/3 Reference Voltage Analog Telemetry Interface Circuit

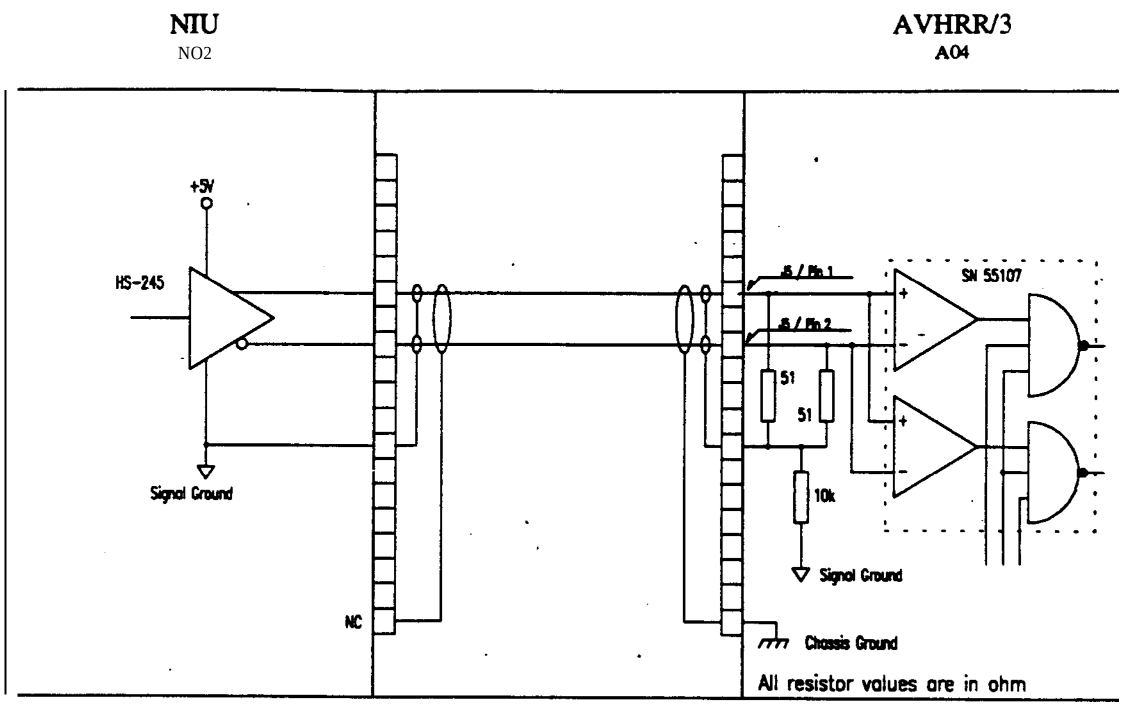


Fig. 3.5.2.2-7 : 0.9984 ***MHz Clock*** *Interface Circuit*

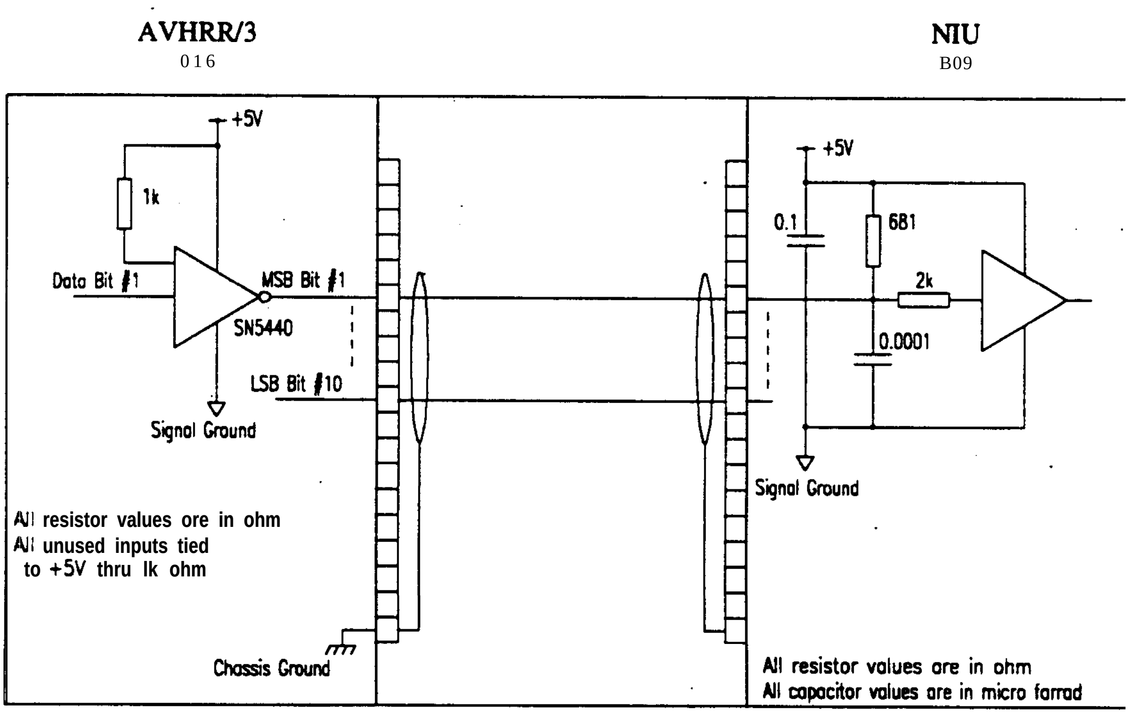


*Fig. 3.5.2.2-8 : A **VHRR/3** Data Line **Interface** Circuit*

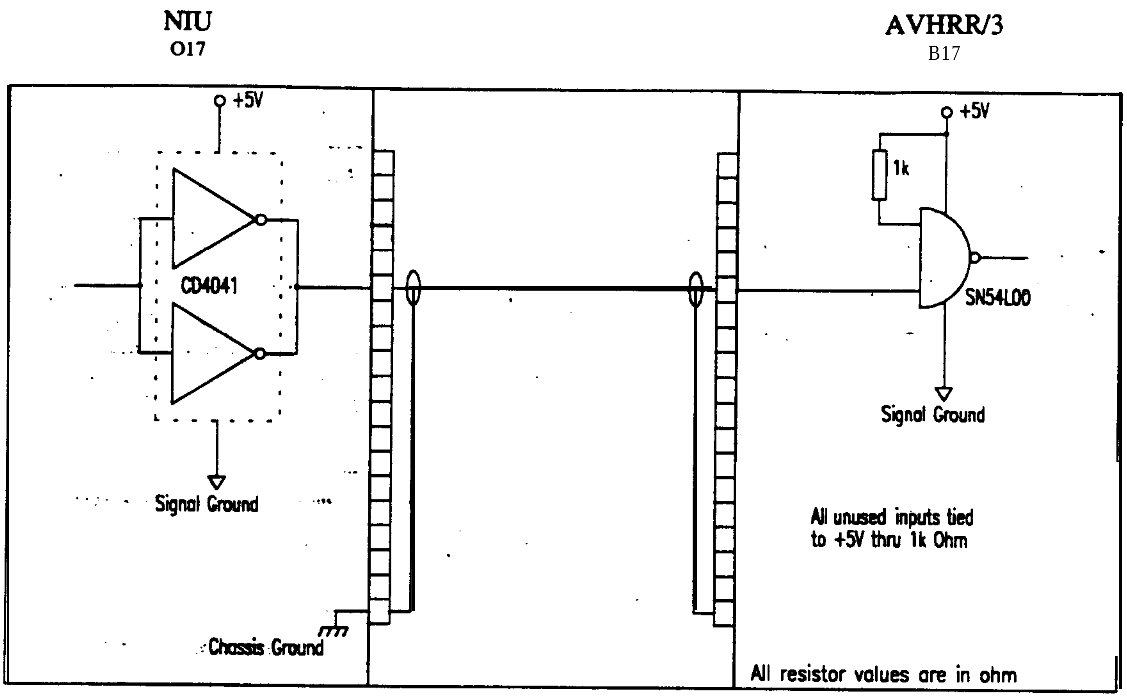
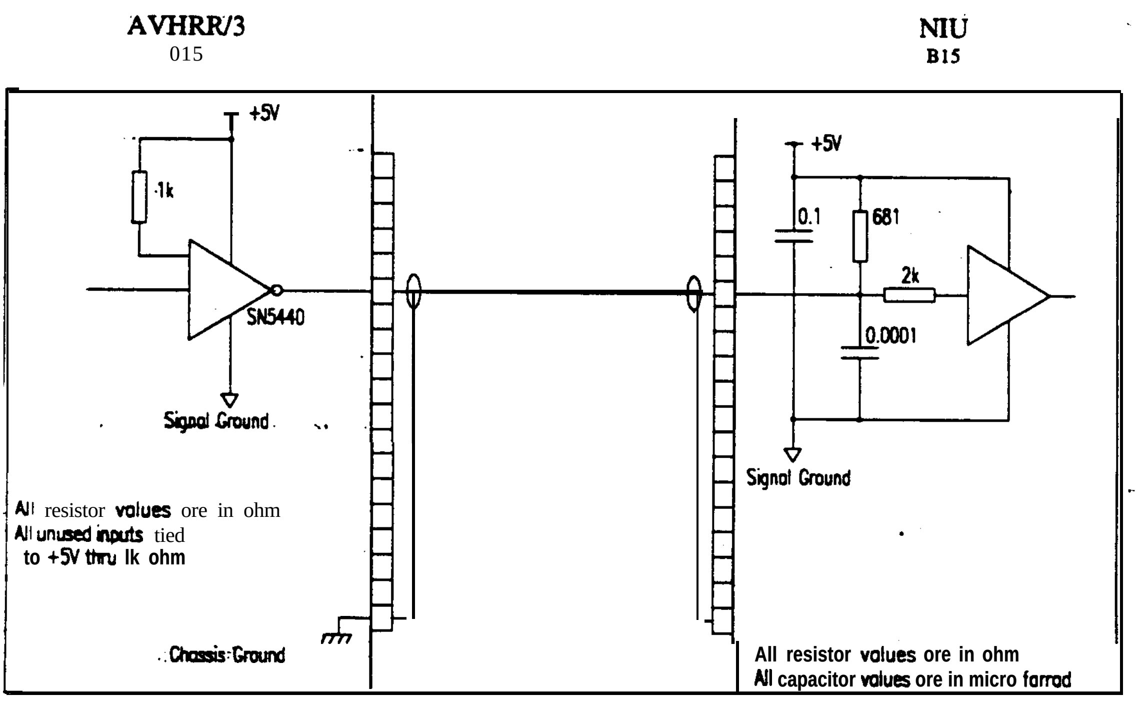


Fig. 3.5.2.2-9 *: AVHRR/3 Data Sample Pulse Interface Circuit*



'Fig. 3.5.2.2-10 : AVHRR/3 Line Sync. Pulse Interface Circuit

3.5.3. Signal Electrical Connectors

Table 3.5.3-1 identifies the signal electrical connector types at the AVHRR/3 boxes and Table 3.5.3-2 identifies the signal electrical connector types at the AVHRR/3 harness.

Connector	Connector-Type	Function
J01	TD1C37TP *)	Command
J02	TD1B25MS *)	Digital TM
J04	TD1C37MS *)	Analog TM
J05	TD1E9HP *)	Clock
J06	TD1A15HP *)	Data Processor

*) ITT-Cannon filter pin connector

Table 3.5.3-1 : Signal Electrical Connector Types at AVHRR/3 Boxes

Connector	Connector-Type	Function
P01	DCMA-37S-NMB	Command
P02	DBMA-25P-NMB	Digital TM
P04	DCMA-37P-NMB	Analog TM
P05	DEMA-9S-NMB	Clock
P06	DAMA-15S-NMB	Data Processor

Table 3.5.3-2 : Signal Electrical Connector Types at AVHRR/3 Harness

3.5.4. Signal Electrical Pin Allocation Lists

In these lists, the cross reference between connector pin, signal designation, Interface Data Sheet, target connector and target connector pin is defined and recorded as data base. Per connector one list is prepared

Interface Data Sheets can be found in § 3.5.2.1.

The individual pin allocation lists are specified by 9 characters of a alpha numerical connector number. For the AVHRR/3, the first 3 characters are AVH. The 7th character is J for a box connector or P for a harness connector. The last two characters define the connector number.

Since these lists also specify the wiring and shielding, they also form the basis for harness manufacturing.

The signal connector pin allocations at instrument level are described in Tables 3.5.4/1 to /5. The signal connector harness are described in Tables 3.5.4/6 to /10.

Note that the following instrument connector pins are currently spared on TIROS applications :

Connector	Table #	Pin Number	TIROS Assignment
J 01	3.5.4/1	34 35	Spare Spare
JO2	3.5.4/2	22 23	Spare Spare
JO4	3.5.4/3	34 35	Spare Spare

Connector : 2AVH305J01 Item : AVHRR/3 **Function :** Command **Backshell :** N/A
EMC-Category : 2 **Conn.-Type :** TD1C37TP

Pin	Signal Designation		Circ	Signal	Pos.	Ch. ID	Shd	Cable	Twist	Comment	New
			Interface-Code			Grouping					
01	Elec/TLM ON AVH	.SIG	B14	CCP- -	D	CP00					
02	Elec/TLM OPFAVH	.SIG	B14	CCP- -	D	CP01					
03	Mot/TLM ON AVH	.SIG	B14	CCP- -	D	CP02					
04	Mot/TLM OFF AVH	.SIG	B14	CCP- -	D	CP03					
05	TLM NoLock ON AVH	.SIG	B14	CCP- -	D	CP04					
06	TLM Lock ON AVH	SIG	B14	CCP- -	D	CP05					
07	CH 1 En AVH	.SIG	B14	CCP- -	D	CP06					
08	CH 1 Dis AVH	SIG	B14	CCP- -	D	CPo7					
09	CH 2 En AVH	.SIG	B14	CCP- -	D	CP08					
10	CH 2 Dis AVH	.SIG	B14	CCP- -	D	CP09					
11	CH 4 En AVH	.SIG	B14	CCP- -	D	CP10					
12	CH 4 Dis AVH	.SIG	B14	CCP- -	D	CP11					
13	CH 3B En AVH	SIG	B14	CCP- -	D	CP12					
14	CH 3B Dis AVH	.SIG	B14	CCP- -	D	CP13					
15 .	Scan Mot Lo AVH	SIG	B14	CCP- -	D	CP14					
16	Scan Mot Hi AVH	SIG	B14	CCP- -	D	CP15					
17	Spare	.-									
18	Spare	.-									
19	Spare	.-									
20	PatchCtl OFF AVH	.SIG	B14	CCP- -	D	CP16					
21	PatchCtl ON AVH	SIG	B14	CCP- -	D	CP17					
22	EarthShd Dis AVH	.SIG	B14	CCP- -	D	CP18					
23	EarthShd Dpl AVH	.SIG	B14	CCP- -	D	819					
24	CoolrHeat OFF AVH	.SIG	B14	CCP- -	D	CP20					
25	CoolrHeat ON AVH	.SIG	B14	CCP- -	D	CP21					
26	VoltCal OFF AVH	.SIG	B14	CCP- -	D	CP22					
27	VoltCal On AVH	.SIG	B14	CCP- -	D	CP23					
28	CH 5 En AVH	.SIG	B14	CCP- -	D	CP24					
29	CH 5 Dis AVH	.SIG	B14	CCP- -	D	CP25					
30	CH 3A En AVH	.SIG	B14	CCP- -	D	CP26					
31	CH 3A Dis AVH	.SIG	B14	CCP- -	D	CP27					
32	CH 3A Sel AVH	.SIG	B14	CCP- -	D	CP28					
33	CH 3B Sel AVH	.SIG	B14	CCP- -	D	CP29					
34	+10V I/F GND A AVH	.RTN		NALR		N700					
35	+10V I/F GND B AVH	.RTN		NALR		N701					
36	Chassis Gnd AVH	.-									
37	Chassis God AVH	.-									

* : METOP requirement.

Table 3.5.4/1 : Pin ***Allocation List of Connector J01***

Connector : 2AVH305J02 **Item :** AVHRR/3 **Function :** Digital TLM **Backshell :** N/A
EMC-category : 2 **Conn.-Type :** TD1B25MS

Pin	Signal Designation		Circ	Signal		Pos.	Ch. ID	Shd	Cable	Twist	Comment	New
			Interface-Code				Grouping					
01	EarthShd Stat AVH	SIG	018	TLD-	-	D	TD00					
02	PatchCtl Stat AVH	SIG	018	TLD-	-	D	TD01					
03	Spare	-										
04	ScanMotModeStat AVH	SIG	018	TLD-	-	D	TD02					
05	VoltCal Stat AVH	SIG	018	TLD-	-	D	TD03					
06	CoolrHeat Stat AVH	SIG	018	TLD	-	D	TD04					
07	Elec/TLM Stat AVH	SIG	018	TLD-	-	D	TD05					
08	Mot/TLM Stat AVH	SIG	018	TLD-	-	D	TD06					
09	TLM Lock Stat AVH	SIG	018	TLD-	-	D	TD07					
10	CH 1 Stat AVH	SIG	018	TLD-	-	D	TD08					
11	CH 2 Stat AVH	SIG	018	TLD-	-	D	TD09					
12	CH 4 Stat AVH	SIG	018	TLD-	-	D	TD10					
13	CH 3B Stat AVH	SIG	018	TLD-	-	D	TD11					
14	CH 5 Stat AVH	SIG	018	TLD-	-	D	TD12					
15	CH 3A Stat AVH	SIG	018	TLD-	-	D	TD13					
16	CH3A/3B OutSel AVH	SIG	018	TLD-	-	D	TD14					
17	Spare	-										
18	Spare	-										
19	Spare	-										
20	Spare	-										
21	Spare	-										
22	+10V I/F GND C AVH	RTN		NALR	-		N702					
23	+10V I/F GND D AVH	RTN		NALR	-		N703					
25	Chassis Gnd AVH	-										
25	Chassis Gnd AVH	-										

• : METOP requirement.

Table 3.5.4/2 : Pin Allocation List of Connector J02

Connector : 2AVH305J04 Item : AVHRR/3 Function : Analog TLM Backshell : N/A
EMC-Category : 2 **Conn.-Type :** TD1C37MS

Pin	Signal Designation		Circ	Signal	Pas.	Ch. ID	Shd	Cable	Twist	Comment	New
			Interface-Code			Grouping					
01	Radiator Temp AVH	.SIG	019	TLA- -	D	TA00					
02	Pat Pwr AVH	SIG	019	TLA- -	D	TA01					
03	PatTempLoRng AVH	.SIG	019	TLA- -	D	TA02					
04	PatTempTLMExtRng AVH	.SIG	019	TLA- -	D	TA03					
05	Blackbody1 Temp AVH	SIG	019	TLA- -	D	TA04					
06	Blackbody2 Temp AVH	SIG	019	TLA- -	D	TA05					
07	Blackbody Temp AVH	SIG	019	TLA- -	D	TA06					
08	Blackbody Temp AVH	.SIG	019	TLA- -	D	TA07					
09	Mot Curr (DC) AVH	SIG	019	TLA- -	D	rA08					
10	Elec Curr AVH	SIG	019	TLA- -	D	TA09					
11	Earth Shd Pos AVH	.SIG	020	TLA- -	D	TA10					
12	Elec Temp AVH	SIG	019	TLA- -	D	TA11					
13	BasePlateTemp AVH	.SIG	319	TLA- -	D	TA12					
14	AID Conv Temp AVH	SIG	319	TLA- -	D	TA13					
15	Ma Hsg. Temp AVH	.SIG	319	TLA- -	D	TA14					
16	CoolrHsg.Temp AVH	.SIG	319	TLA- -	D	TA15					
17	DetBiasVolt CH4 AVH	.SIG	321	TLA- -	D	rA16					
18	DetBiasVolt CH5 AVH	SIG	321	TLA- -	D	TA17					
19	IR CH4 BB Temp AVH	.SIG	319	TIA- -	D	TA18					
20	IR CH3B BB Temp AVH	SIG	019	TLA- -	D	TA19					
21	Ref Volt AVH	.SIG	322	TLA- -	D	TA20					
22	IR CH5 BB Temp AVH	SIG	019	TLA- -	D	TA21					
23	Spare	.-									
24	Spare	.-									
25	Spare	.-									
26	Spare	.-									
27	Spare	.-									
28	Spare	.-									
29	Spare	.-									
30	Spare	.-									
31	Spare	.-									
32	Spare	.-									
33	Spare	.-									
34	Signal GND A AVH	.GND		GND- -		GN10				*	
35	Signal GND B AVH	.GND		GND- -		GN11				*	
36	Chassis Gnd AVH	.-									
37	Chassis Gnd AVH	.-									

* : METOP requirement.

Table 3.5.4/3 : Pin *Allocation* List of Connector JO4

Connector : FAVH305J05 Item : AVHRR/3 Function : Clock Backshell : N/A
EMC-Category : F Conn.-Type : TD1 E9HP

Pin	Signal Designation		Interface-Code Circ	Signal	Pa	Grouping Ch. ID	Shd	Cable	Twist	Comment	New
01	0.9984 MHz Clock AVH	SIG	A04	CLS- . -	D	CS00	1.				
02	0.9984 MHz Clock AVH	.INV	A04	a s -	- B.	CS00	1				
03	CABLESHIELD	.SHD	PHD		- 7		1			sa Fig. 3.5.2.2-7	
04	OVERALL SHIELD	.SHD	EHD		- 0						
05	Chassis Gnd AVH	.-									
06	Spare	.-									
07	Spare	.-									
08	Spare	.-									
09	Spare	.-									

Table 3.5.4/4 : Pin Allocation List of Connector JO5

Connector : 2AVH305J06 Item : AVHRR/3 Function : Data Processor Backshell : N\A
EMC-Category : 2 Conn.-Type : TD1A15HP

Pin	Signal Designation		Interface-Code Circ	Signal	Pos.	Grouping Ch. ID	Shd	Cable	Twist	Comment	iew
01	Data Lines AVH	.SI2^9	316	DOV-	- D	DO00					
02	Data Lines AVH	.SI2^8	316	DOV-	- D	DO00					
03	Data Lines AVH	.SI2^7	016	DGV-	- D	DO00				special cable as per	
04	Data Lines AVH	.SI2^6	016	DOV-	- b	DO00				Fig. 3.5.2.2-8	
05	Data Lines AVH	.SI2^5	016	DOV-	- D	DGOO					
06	Data Lines AVH	.SI2^4	016	DOV-	- D	DO00					
07	Data Lines AVH	.SI2^3	016	DOV-	- D	DO00				all Data Lines	
08	Data Lines AVH	.SI2^2	016	DOV-	- D	DO00				shielded together by	
09	Data Lines AVH	.SI2^1	016	DOV-	- D	DGOO				COMMON SHIELD	
10	Data Lines AVH	.SI2^0	016	DOV-	- D	DO00.				Pin 11	
11	COMMON SHIELD	.SHD	SHD		- 0						
12	DataSample Pulse AVH	SIG	017	DEV-	- D	DE00				see Fig. 3.5.22-9	
13	Chassis Ground AVH	.-									
14	Line Sync Pulse AVH	SIG	015	SYS-	- D	SSOO				see Fig. 3.5.2.2-10	
15	CABLE SHIELD	.SHD	SHD		- 0						

Table 3.5.4/5 : Pin Allocation List of Connector JO6

Connector : **2AVH305P01** **Item :** **AVHRR/3** Function : Command **Conn.-Type : DCMA-37S-NMB**
EMC-Category : 2 **Location :** 305 **Backshell :** T B D

			Interface-Code			Grouping											
Pin	**Signal Designation**		**Circ**	**Signal**	**Pos.**	**Ch. ID**	**Wiring**	Shd	**Cable**	**Twist**	**Comment**	**End-It.**	**Loc.**	**Connector**	**Pin**	**New**
01	Elec/TLM ON AVH	.SIG	B14	CCP-	- D	WOO	SL-24					NIU	240	NHJ240 Pxx		
02	Elec/TLM OFF AVH	.SIG	B14	CCP-	- D	CP01	SL-24					NIU	240	NIU240 Pxx		
03	Mot/TLM ON AVH	SIG	D14	CCP-	- D	cFO2	SL-24					NIU	240	NIU240 Pxx		
04	Mot/TLM OFF AVH	.SIG	B14	CCP-	- D	CP03	SL-24					NIU	240	NIU240 Pxx		
05	TLM NoLock ON AVH	.SIG	B14	CCP-	- D	CP04	SL-24					NIU	240	NIU240 Pxx		
06	TLM Lock ON AVH	.SIG	B14	CCP-	- D	CP05	SL-24					NIU	240	NIU240 Pxx		
07	CH I En AVH	SIG	B14	CCP-	- D	CP06	SL-24					NIU	240	NIU240 Pxx		
08	CH I Dis AVH	.SIG	B14	CCP-	- D	CP07	SL-24					NIU	240	NIU240 Pxx		
09	CH 2 En AVH	.SIG	B14	CCP-	- D	CP08	SL-24					NIU	240	NIU240 Pxx		
10	Ct12 Dis AVH	.SIG	B14	CCP-	- D	CP09	SL-24					NIU	240	NIU240 Pxx		
11	Ct14 En AVH	.SIG	B14	CCP-	- D	CP10	SL-24					NIU	240	NIU240 Pxx		
12	CH 4 Dis AVH	.SIG	B14	CCP-	- D	CP11	SL-24					NIU	240	NIU240 Pxx		
13	CH 3B En AVH	.SIG	B14	CCP-	- D	CP12	SL-24					NIU	240	NIU240 Pxx		
14	CH 3B Dis AVH	.SIG	B14	CCP-	- D	CP13	SL-24					NIU	240	NIU240 Pxx		
15	Scan Mot Lo AVH	SIG	B14	CCP-	- D	CP14	SL-24					NIU	240	NIU240 Pxx		
16	Scm Mot Hi AVH	SIG	B14	CCP-	- D	CP15	SL-24					NIU	240	NIU240 Pxx		
17	Spare	.-														
18	Spare	.-														
19	Spare	.-														
20	PatchCtl OFF AVH	.SIG	B14	CCP-	- D	CP16	SL-24					NIU	240	NIU240 Pxx		
21	PatchCtl ON AVH	.SIG	B14	CCP-	- D	CP17	SL-24					NIU	240	NIU240 Pxx		
22	EarthShd Dis AVH	SIG	B14	CCP-	- D	CP18	SL-24					NIU	240	NIU240 Pxx		
23	EarthShd Dpl AVH	SIG	B14	CCP-	- D	(‘PI9	SL-24					NIU	240	NIU240 Pxx		
24	CoolrHeat OFF AVH	SIG	B14	CCP-	- D	CP20	SL-24					NIU	240	NIU240 Pxx		
25	CoolrHeat ON AVH	.SIG	B14	CCP-	- D	CP21	SL-24					NIU	240	NIU240 Pxx		
26	VoltCal OFF AVH	.SIG	B14	CCP-	- D	CP22	SL-24					NIU	240	NIU240 Pxx		
21	VoltCal On AVH	.SIG	B14	CCP-	- D	cP23	SL-24					NIU	240	NIU240 Pxx		
28	CH 5 En AVH	.SIG	B14	CCP-	- D	CP24	SL-24					NIU	240	NIU240 Pxx		
29	CH 5 Dis AVH	.SIG	B14	CCP-	- D	CP25	SL-24					NIU	240	NIU240 Pxx		
30	CH 3A En AVH	.SIG	B14	CCP-	- D	Cl’26	SL-24					NIU	240	NIU240 Pxx		
31	CH 3A Dis AVH	.SIG	B14	CCP-	- D	cP27	SL-24					NIU	240	NIUWO Pxx		
32	Ctl 3A Sel AVH	.SIG	B14	CCP-	- D	CP28	SL-24					NIU	240	NIU240 Pxx		
33	CH 3B Sel AVH	SIG	B14	CCP-	- D	CP29	SL-24					NIU	240	NIU240 Pxx		
34	+10V t/FOND A AVH	.RIN		NALR		N700	SL-24					NIU	240	NIU240 Pxx		
35	+10V I/F GND B AVH	.RTN		NALR		N701	SL-24					NIU	240	NIU240 Pxx		
36	Chassis Gnd AVH	.-														
37	Chassis Gnd AVH	.-														

*Table **3.5.4/6** : Pin Allocation List of Connector **P01***

*(For **Information Only**)*

Connector : 2AVH305P02 Item : AVHRR/3 Function : Digital TLM Conn.-Type : DBMA-25P-NMB
EMC-Category : 2 Location : 305 Backshell : TBD

Pin	Signal Designation		Interface-Code Circ	Signal		Pos.	Grouping Ch. ID	Wiring	Shd	Cable	Twist	Comment	End-It.	Loc.	Connector	Pin	New
01	EarthShd Stat AVH	SIG	O18	TLD-	-	e	TD00	SL-24					NIU	240	NIU240 Pxx		
02	PatchCtl Stat AVH	.SIG	O18	TLD-	-	e	TD01	SI-K					NIU	240	NIU240 Pxx		
03	Spare																
04	ScanMotModeStat AVH	.SIG	O18	∩-∩	-	e	TD02	SL-24					NIU	240	NIU240 Pxx		
0S	VoltCal Stat AVH	.SIG	018	∩-∩	-	e	TD03	SL-24					NIU	ttO	NIU240 Pxx		
06	CoolrHeat Stat AVH	.SIG	O18	TLD-	-	e	TD04	SL-24					NIU	240	NIU240 Pxx		
07	Elec/TLM Stat AVH	.SIG	018	TLD-	-	e	TD05	SL-24					NIU	240	NIU240 Pxx		
08	Mot/TLM Stat AVH	SIG	018	TLD-	-	e	t.e06	SI-K					NIU	ZdO	NIU240 Pxx		
09	TLM Lock Stat AVH	.SIG	018	TLD-	-	e	TD07	SL-24					NIU	240	NIU240 Pxx		
10	CH I Stat AVH	.SIG	018	n-e-	-	e	TD08	SL-24					NIU	ZdO	NIU240 Pxx		
II	CH Z Stat AVH	.SIG	O18	TLD-	-	e	TD09	SL-24					NIU	240	NIU240 Pxx		
12	CH 4 Stat AVH	.SIG	018	TLD-	-	e	TD10	SL-24					NIU	ZdO	NIU240 Pxx		
13	CH 3B Stat AVH	.SIG	018	TLD-	-	e	TD11	SI-K					NIU	240	NIU240 Pxx		
14	CH S Stat AVH	.SIG	018	TLD-	-	e	TD12	SL-24					NIU	ZdO	NIU240 Pxx		
15	CH 3A Stat AVH	.SIG	018	TLD-	-	e	TD13	SL-24					NIU	240	NIU240 Pxx		
16	CH3A/3B OutSel AVH	SIG	O18	TLD-	-	e	TD14	SL-24					NIU	240	NIU240 Pxx		
17	Spare	.-															
18	Spare	.-															
19	Spare	.-															
Z0	Spare	.-															
TI	Spare	.-															
ZZ	+10V I/F GND C AVH	.RTN		NALR	-		N702	SL-24					NIU	ZdO	NIU240 Pxx		
23	+10V I/F GND D AVH	.RTN		NALR	-		N703	SL-24					NIU	240	NIU240 Pxx		
25	Chassis Gnd AVH	.-															
25	Chassis Gnd AVH	.-															

Table 3.5.4/7 : Pin Allocation List of Connector P02

(For Information Only)

Connector : 2AVH305P04 **Item :** AVHRR/3 Function : Analog TLM **Conn.-Type :** DCMA-37P-NMB
EMC-Category : 2 **Location :** 305 **Backshell : TBD**

Pin	Signal Designation		Circ	Signal	P	a	Ch. ID	Wiring	Shd	Cable	Twist	Comment	End-IL	Loc.	Connector	Pin	New
			Interface-Code					Grouping									
01	Radiator Temp AVH	.SIG	O19	TLA-	-	D	TA00	SL-24					NIU	240	NIU240 Pxx		
02	Pat Pwr AVH	SIG	O19	TLA-	-	D	TA01	SL-24					NIU	240	NIU240 Pxx		
03	PatTempLoRng AVH	.SIG	O19	TLA-	-	D	TA02	SL-24					NIU	240	NIU240 Pxx		
04	PatTempTLMExtRng AVH	.SIG	O19	TLA-	-	D	TA03	SL-24					NIU	240	NIU240 Pxx		
05	Btackbodyt Temp AVH	.SIG	O19	TLA-	-	D	TA04	St.-24					NIU	240	NIU240 Pxx		
06	Blackbody2 Temp AVH	.SIG	O19	TLA-	-	D	TA05	SL-24					NIU	240	NIU240 Pxx		
07	Blackbody3 Temp AVH	SIG	O19	TLA-	-	D	TA06	SL-24					NIU	240	NIU240 Pxx		
08	Blackbody4 Temp AVH	SIG	O19	TLA-	-	D	TA07	SL-24					NIU	240	NIU240 Pxx		
09	Mot Curr (DC) AVH	.SIG	O19	TLA-	-	D	TA08	SL-24					NIU	240	NIU240 Pxx		
10	Etec Curr AVH	.SIG	O19	TLA-	-	D	TA09	SL-24					NIU	240	NIU240 Pxx		
11	Earth Shd Pos AVH	SIG	O20	TLA-	-	D	TA10	SL-24					NIU	240	NtU240 Pxx		
12	Elec Temp AVH	SIG	O19	TLA-	-	D	TA11	SL-24					NIU	240	NIU240 Pxx		
13	BasePlateTemp AVH	.SIG	O19	TLA-	-	D	TA12	SL-24					NIU	240	NIU240 Pxx		
14	A/D Conv Temp AVH	.SIG	O19	TLA-	-	D	TA13	SL-24					NIU	240	NIU240 Pxx		
15	Mot Hsg. Temp AVH	SIG	)19	TLA-	-	D	TA14	SL-24					NIU	240	NIU240 Pxx		
16	CoolrHsg.Temp AVH	SIG	)19	TLA-	-	D	TA15	SL-24					NIU	240	NIU240 Pxx		
17	DetBiasVolt CH4 AVH	.SIG	)21	TLA-	-	D	TA16	SL-24					NIU	240	NIU240 Pxx		
18	DetBiasVolt CH5 AVH	.SIG	)21	TLA-	.	D	TA17	SL-24					NIU	240	NIU240 Pxx		
19	IR CH4 BB Temp AVH	.SIG	)19	TLA-	-	D	TA18	SL-24					NIU	240	NIU240 Pxx		
20	IR CH3B BB Temp AVH	.SIG	)19	TLA-	-	D	TA19	SL-24					NIU	240	NIU240 PM		
21	Ref Volt AVH	.SIG	)22	TLA-	-	D	TA20	St.-24					NIU	240	NIU240 Pxx		
22	IR CH5 BB Temp AVH	.SIG	)19	TLA-	-	D	TA21	SL-24					NIU	240	NIU240 Pxx		
23	Spare	.-															
24	Spare	.-															
25	Spare	.-															
26	Spare .	.-															
27	Spare	.-															
28	Spare	.-															
29	Spare	.-															
30	Spare	.-															
31	Spare	.-															
32	Spare	.-															
33	Spare	.-															
34	Signal GND A AVH	.GND		GND-	-		GN10	SL-20					NIU	240	NIU240 Pax		
35	Signal GND B AVH	.GND		GND-	-		GN11	SL-20					NIU	240	NIU240 Pxx		
36	Chassis Gnd AVH	.-															
37	Chassis Gnd AVH	.-															

Table 3.5.4/8 : Pin Allocation List of Connector PO4

(For Information Only)

Connector : FAVH305P05 Item : AVHRR/3 Function : Clock Conn.-Type : DEMA-09S-NMB
EMC-Category : F Location : 305 Backshell : TBD

Pin	Signal Designation		Interface-Code Circ	Signal	Pos.	Grouping Ch. ID	Wiring	Shd	Cable	Twist	Comment	End-It.	Loc.	Connector Pin	New
01	0.9984 MHz Clock AVH	.SIG	A04	CLS-	- D	CS00	COAX- I					NIU	240	NIU240 Pxx	
02	0.9984 MHz Clock AVH	.INV	A04	CLS-	- B	CS00	COAX- I					NHJ	240	NIU240 Pxx	
03	CABLE SHIELD	.SHD	SHD		- 7						se? Fig. 3.5.2.2-l	NIU	240	NIU240 Pxx	
04	OVERALL SHIELD	.SHD	SHD		- 0										
05	Chassis Gnd AVH	.-													
06	Spare	.-													
07	Spare	.-													
08	Spare	.-													
09	Spare	.-													

Table 3.5.4/9 : Pin Allocation List of Connector P05

(For Information Only)

Connector : 2AVH305P06 Item : AVHRR/3 Function : Data Processor Conn.-Type : DAMA-15S-NMB
EMC-Category : 2 Location : 305 Backshell : . TBD

Pin	Signal Designation		Interlace-Code Circ	Signal	Pa	Grouping Ch. ID	Wiring	Shd	Cable	Twist	Comment	End-It.	Loc.	Connector Pin	New
01	Data Lines AVH	.SI2^9	O16	DOV-	- D	DGOO	SL-24					NIU	240	NIU240 Pxx	
02	Data Linw AVH	.SI2^8	O16	DOV-	- D	DO00	SL-24					NIU	240	NIU240 Pxx	
03	Data Linw AVH	.SI2^7	016	DOV-	- D	DO00	SL-24				special cable	NIU	240	NIU240 Pxx	
04	Data Lines AVH	.SI2^6	016	DOV-	- D	DO00	SL-24				as per	NIU	240	NIU240 Pxx	.
05	Data Linw AVH	.SI2^5	016	DOV-	- D	DO00	SL-24				Fig. 3.5.2.2-g	NIU	240	NIU240 Pxx	
06	Data Linw AVH	.SI2^4	016	DOV-	- D	DO00	SL-24					NIU	240	NIU240 Pxx	
07	Data Lines AVH	.SI2^3	016	DOV-	- D	DG00	SL-24				all Data Lines	NIU	240	NIU240 Pxx	
08	Data Linw AVH	.SI2^2	016	DOV-	- D	DO00	SL-24				shielded together by	NIU	240	NIU240 Pxx	
09	Data Lines AVH	.SI2^1	016	DOV-	- D	DO00	SL-24				COMMON SHIELD Pin 1I	NIU	240	NIU240 Pxx	
I0	Data Linw AVH	.SI2^0	016	DOV-	- D	DO00	SL-24					NIU	240	NIU240 Pxx	
II	COMMON SHIELD	.SHD	SHD		- 0										
I2	DataSample Pulse AVH	.SIG	017	DEV-	- D	DE00	SSL-24				see Fig. 3.5.2.2-9	NIU	240	NIU240 Pxx	
13	Chassis Ground AVH	.-													
14	Line Sync Pulse AVH	SIG	O15.	SYS-	- D	SS00	SSL-24				see Fig. 3.5.2.2-10	NIU	240	NIU240 Pxx	
15	CABLE SHIELD	.SHD	SHD		- 0							NIU	240	NIU240 Pxx	

Table 3.5.4/10 : Pin Allocation List of Connector PO6

(For Information Only)

3.6. TEST INTERFACES

3.6.1. Electrical Test Interface Requirements

3.6.1.1. Interface Data Sheets

N/A.

3.6.1.2. Interface Circuits

N/A.

3.6.2. Electrical Test Interface! Connectors

Table 3.6.2-l identifies the test connector type at the AVHRR/3 box.

This connector is not for use on the METOP satellite.

Connector	Connector-Type	Function
JO7	311P405-5S-C-12	Test

Table 3.6.2-I : Test Connector Types at AVHRR/3 Boxes'

3.6.3. Electrical Test Interface Pin Allocation List

N/A.

3.7. HARNESS

The harness between METOP units and the AVHRR/3 is under the responsibility of the PLM. based on the connector & pin lay-out definition and electrical performances from § 3.4 and 3.5.2.

3.8. EMC INTERFACE DESCRIPTION

3.8.1. Electrical Bonding

3.8.1.1. General

The AVHRR/3 is electrically bonded to the METOP spacecraft structure by means of a METOP suppliedbonding strapthatis bolted to the instrument at location TBD_{MET}..

3.8.1.2. Joint Faces

Not applicable for AVHRR/3.

3.8.1.3. structural Parts

Not applicable for AVHRR/3.

3.8.1.4. Unit Housings

3.8.1.4.1. Bonding of Unit Cases

All 'unit cases within the AVHRR/3 are electrically connected with the box feet. METOP accommodation bonds the AVHRR/3 feet to the spacecraft structure.

3.8.1.4.2. Bonding of Thermally Isolated Boxes

N/A to AVHRR/3.

3.8.1.4.3. Bonding of Unit Mounted on CFRP of Non-Conductive Parts

N/A to AVHRR/3.

3.8.1.4.4. DC Resistance Between Adjacent Unit Case Parts

N/A to AVHRR/3.

3.8.1.4.5. DC Resistance Between Bonding Stud and Mounting Feet

N/A to AVHRR/3.

3.8.1.5. Thermal Blankets

3.8.1.5.1. Bonding of Thermal Blankets

Thermal blanket foil shall carry a conductive layer. Each electrically conductive layer of MLI shall be grounded to structure. Surfaces which are smaller than 100 cm^2 do not need to be grounded to structure.

The number of bonding points per sheet of MLI material shall be at least two points, at diagonal comers.

3.8.1.5.2. Thermal Blanket Surface Resistance

The DC resistance between the MLI bonding point and any point belonging the metallized face Of any foil shall be less than 50 Ω. (tbc HIRS)

3.8.1.6. **Other Conductive Components**

N/A to AVHRR/3.

3.8.1.7. Cable and Harness Shields

N/A for **AVHRR/3**.

3.8.1.8. Connectors.

Bonding Resistance of Connector Receptacle

The connector receptacle shall be bonded to the equipment case with a DC resistance of ≤ 10 mΩ.

3.8.2. Grounding and Isolation

The grounding system of the instrument shall use separate grounds (see Figure **3.8.2-l) as** follows :

- **+ 28** V Main Power Ground and + 28 V Motor Ground
- **+ 10 V Interface Ground**
- Signal Ground
- Chassis Ground

Each ground shall be electrically isolated from all other grounds within the instrument and from chassis by 100 **kΩ** or greater DC resistance **(TBC_{AVH})** in parallel ~~with a stray capacitance of ≤ 1 µF (TBC)~~.

Between the signal ground and the **+28** V main power ground, the isolation requirement shall be 1 MS2 DC resistance **in parallel** ~~with a stray capacitance of ≤ 50 nF (TBC).~~

3.8.2.1. + 28 **V Main Power Ground and + 28 V Motor Power Ground**

The + 28 V main power retum and motor power return are grounded within the PCU to structure.

3.8.2.2. + 10 V Interface Ground

The + 10 V **interface** return is grounded within NIU to structure.

3.8.2.3. Signal Ground

Signal ground is the power return line for the secondary side of the instrument DC/DC converters. The signal ground is provided on a pin of an **instrument** connector.

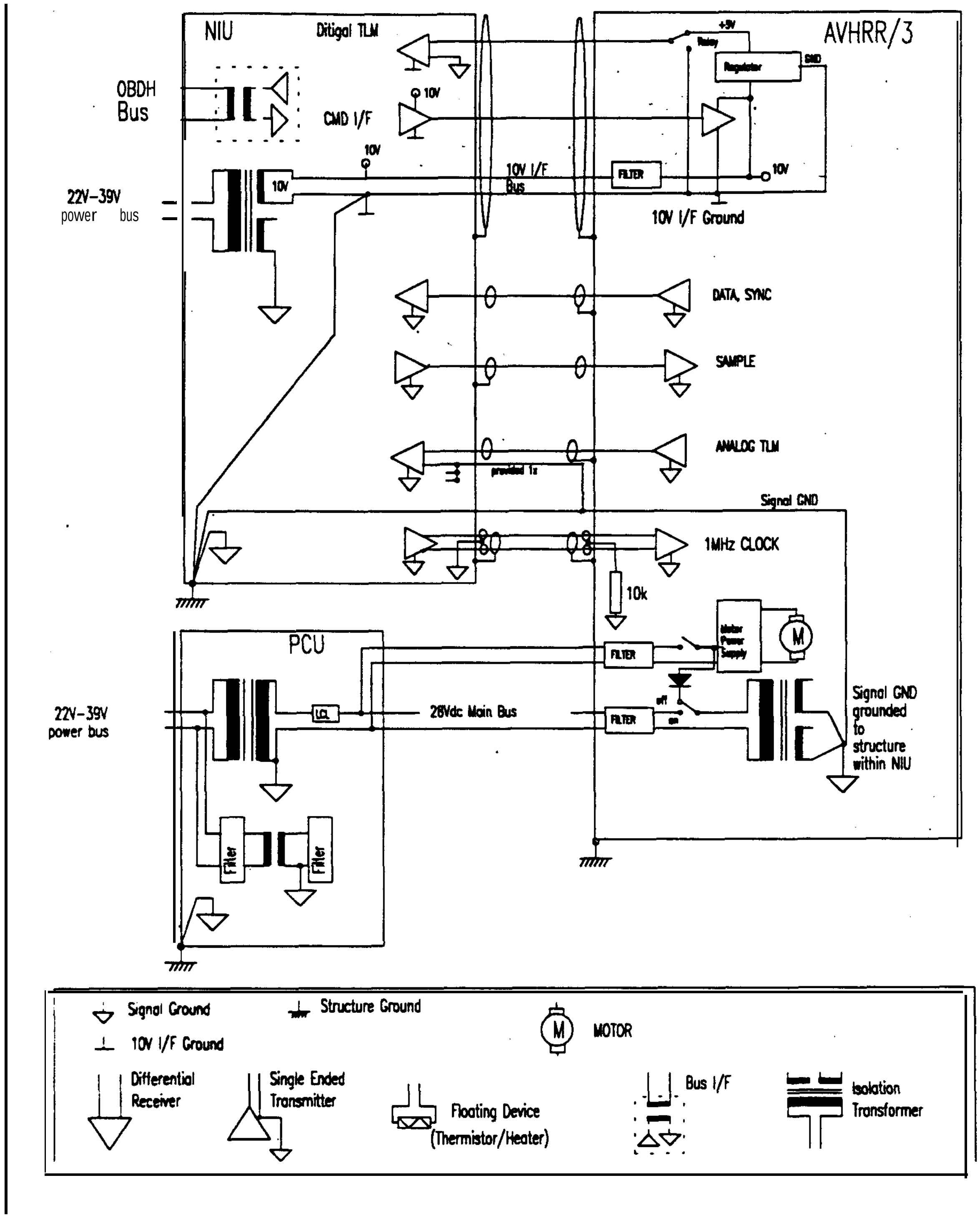


Figure 3.8.2-l : Grounding and Isolation Concept for ***AVHRR/3***

3.8.3. Shielding

3.8.3.1. Wire Shielding

3.8.3.1.1. Bonding of Shields

N/A

3.8.3.1.2. Overall Shield

N/A

3.8.3.1.3. Shields as Current-Carrying Conductors

Shields shall not be used as intentional current-carrying conductors and not as return lines for power and signal with the exception of the RF coaxial lines.

3.8.3.2. Case Shielding

N/A to AVHRR/3.

3.8.4. AVHRR/3 Frequency Characteristics

The following frequencies are derived from the 998.4 kHz clock :

Source	Frequency	User
Switching regulator	960 Hz 240 Hz 62.4 kHz 40 kHz 10 kHz 6 Hz	

The channel characteristics are given in § 1.2.2.

3.85. Magnetic Moment

NASA

The maximum magnetic moment of the instrument shall not exceed 500 mAm² (TBC). The magnetic moment correspond to a magnetic field of 100 nT at 1 m (1 Gauss equals to 10^{-4} T) distance.

List of Magnetic Material

Magnetic materials used in the instrument are listed in Table 3.8.5 .-1

Material	Standard	Magnetic Characteristic	Remark
name of material	*AISI etc.*	*soft /hard*	
TBD_{AVH}	TBD_{AVH}	TBD_{AVH}	

Table *3.8.5.-1 : Magnetic Materials Used in the Instrument*

3.8.6. EMC Performance Requirements

The EMC performances for the AVHRR/3 are dealt within § 4.3.

3.9. RF INTERFACE DESCRIPTION

Not applicable for AVHRR/3.

4. INSTRUMENT VERIFICATION DESCRIPTION

BLANK

4.1. MECHANICAL /STRUCTURAL VERIFICATION

4.1.1. Structural Analysis

4.1.1.1. Quasi-Static Loads

Requirement for analysis will be determined by outcome of accommodation analytic results.

The METOP requirements are dealt with in § 2.2.8.

4.1.1.2. Structural /Dynamic Analyses

Requirement for analysis will be determined by outcome of accommodation analytic results.

4.1.1.3. Instrument Shock Environment

The AVHRR/3 will be subject to the following shock environment, in both launch and in-orbit configuration :

METOP Shock Levels (g peak, See notes)	
100 Hz	37 g
900 Hz	350 g (Q > 10) 310 g (Q = 10)
2000 Hz'	350 g (Q > 10) 310 g (Q = 10)
4000 Hz	300 g

Notes

The acceleration shall be derived from the curve obtained by linear connection on a logarithmic chart of the provided points

The shock spectrum in each direction of the three orthogonal axes shall be equivalent to a half sine pulse of 0.5 ms duration and 200 g (zero to peak) amplitude.

4.1.2. Structural Tests

4.1.2.1. Structural Mathematical Model Validation

Delivered structural mathematical models, as required in § 2.2.8.5.. shall be verified by test and validated.

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4.1.2.2. Vibration Test : High Level Sine Sweep

The AVHRR/3 will be subject to the sine vibration satellite level testing. Preliminary predictions of the worst case imposed environment are as follows :

METOP High Level Sine Sweep Levels (TBC_{MET} *)	
QUAL	**All three axes** 6 to 20 Hz ±9.3 mm 20 to 60 Hz ±15 g 60 to 100 Hz ±6 g sweep rate : 2 Oct/min.
ACC	**All three axes** 6 to 20 Hz ±7.5 mm 20 to 60 Hz ±12 g 60 to 100 Hz ±4.8 g sweep rate : 4 Oct/min.

: To be confirmed / updated after structural model testing.

Notching : TBD_{AVH}

Note : for instruments with natural frequencies below 100 Hz, notching shall be defined to maintain the instrument interface loads within those predicted when the quasi-static design load is applied to the instrument, consistent with the launcher requirements.

Test instrumentation for sine vibration at system level : TBD_{AVH}

4.1.2.3. Vibration Test : Sine Burst

METOP has no sine burst test requirement.

4.1.2.4. Vibration Test : Random Levels

The AVHRR/3 will be subject to an acoustic environment during satellite tests which will result in an equivalent random input at the instrument interface. Preliminary prediction of this input is as follows :

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METOP Random Vibration Levels (TBC$_{MET}$ *)			
	All Three Axes		
Q U A L	Frequency Range (Hz)	Power Spectral Density g^2/Hz	Slope (dB/Oct.)
	20 to 100		+3
	100 to 400	0.107	
	400 to 2000		-3 out-of-plane -4 in-plane
	Overall level : 10.3 g rms normal, 9.5 g rms lateral Duration 2 min per axis		
	All Three Axes		
A C C	Frequency Range (Hz)	Power Spectral Density g^2/Hz	Slope (dB/Oct.)
	20 to 100		+3
	100 to 400	0.069	
	400 to 2000		-3 out-of-plane -4 in-plane
	Overall level : 8.3 g rms normal, 7.6 g rms lateral Duration 1 min per axis		

* : To be confirmed / updated after structural model testing.

4.1.2.5. Acoustic Test

The AVHRR/3 will be subject to an acoustic test at satellite level, as follows :

Octave Band Centre Frequency (Hz)	Qualification Level (dB)	Acceptance Level (Flight Limit)	Test Tolerance (dB)
31.5	132	128	-2, +4
63	134	130	-1, +3
125	139	135	-1, +3
250	143	139	-1. +3
500	138	134	-1. +3
1000	132	128	-1, +3
2000	128	124	-1. +3
4000	124	120	-4, +4
8000	120	116	-4, +4
Overall level	146	142	-1, +3
Test Duration	2 minutes	1 minute	-

The equivalent random environment is illustrated in § 4.1.2.4.

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4.2. THERMAL VERIFICATION : THERMAL TESTS

4.2.1. Thermal **Balance Test**

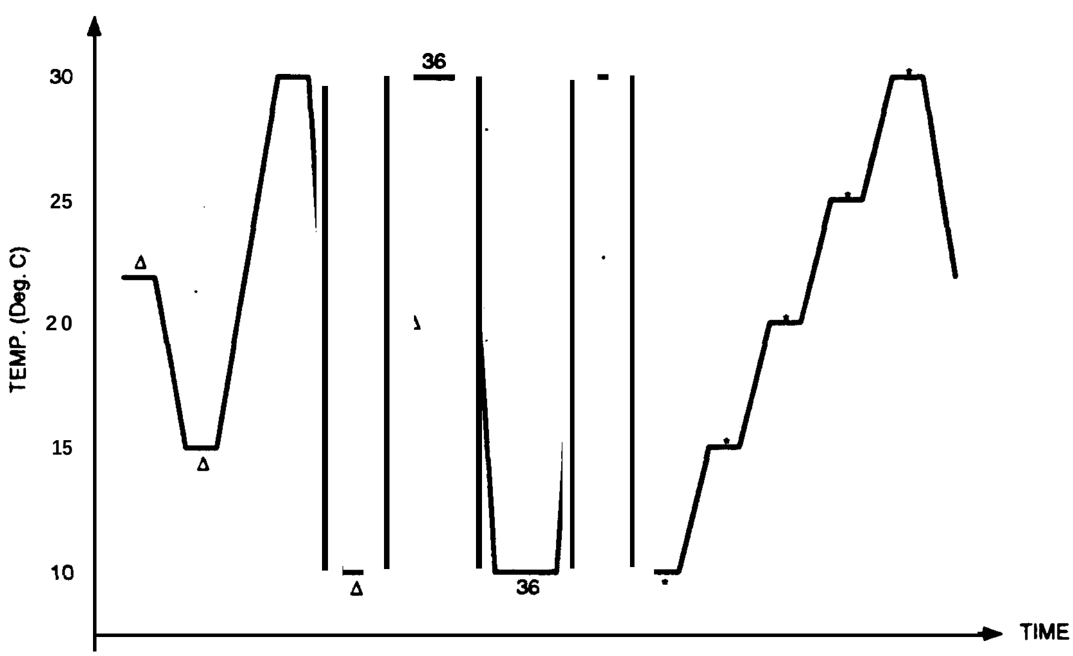
A thermal Balance Test (TB) shall validate the instrument thermal control and accommodation on METOP, and the AVHRR/3 thermal mathematical model used for the temperature predictions for all flight cases (correlation of this instrument model within the METOP thermal environment 'with an accuracy better than ± 5 deg. C on instrument transient and steady-state cases). This will be performed during the METOP system TB test. The evaluation of test results at instrument level is Instrument Supplier responsibility.

4.2.2. Thermal **Vacuum Tests**

The thermal cycle vacuum tests at instrument level evaluate and demonstrate the functional performance of each unit under the extreme and nominal modes of operation while in vacuum and at temperatures more extreme than predicted for the orbit conditions.

The instrument qualification thermal vacuum test includes TBD_{AVH} cycles and the extreme temperature levels are TBD_{AVH} deg. C (min.) / TBD_{AVH} deg. C (Max).

The AVHRR/3 flight acceptance thermal vacuum profile is illustrated in Figure 4.2.2.2/1.



Δ Short Form Performance
ΔΔ Transition 6 deg. C / hour & 2 deg. C / hour
· 2 hours + Cal.

TOLERANCE : Hot +3 deg. C 0 deg. C
Cold 0 deg. C +3 deg. C

*Figure 4.2.2.2/1 : AVHRR/3 Flight Acceptance **Thermal** Vacuum **Profile***

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4.3. EMC VERIFICATION

43.1. EMC Performance Requirements

43.1.1. Conducted Emission

'The conducted emission on each individual power line shah not exceed the limits as given below;

4.3.1.1.1. AVHRR/3 Design Requirements

Conducted Emissions on the +28 Volt Main Bus

Load Current Ripple

The peak to peak amplitude of the steady state load current ripple shall not exceed 40 mA. The fundamental frequency of load current ripple shall not exceed 1 MHz.

inrush Current Rate (Load Current Rate)

The rate of change of load current shall not exceed *20* mA/µs.

inrush Current (Transient Load Current)

Electronics / Telemetry ON.
Electronics / Telemetry ON surge current drawn by the AVHRR/3 does not exceed 3 A peak Steady State operation are attained within 30 ms from the start of the *Electronics / Telemetry ON* transient., The rate of rise of current during the first major current overshoot will not exceed 20 mA/µs except under bus fault conditions. Transient current measurements shall be made with an instrument whose bandwidth is at least 1 MHz.

Motor Start-Up Currents.
Motor start-up current loads are limited to 2.0 A maximum for a period of one second or less. The rate of rise of current during the first major current overshoot for these transients will not exceed 20 mA/µs. Transient current measurements shall be made with an instrument whose bandwidth is at least 1 MHz.

Cooler Decontamination / Cooler Door Opening.
Turn-on transients of the cooler decontamination heater are limited to 3.3 A for a period of 30 ms or less. Cooler door opening transients are limited to 2.1 A for a period of 1 s or less. The rate of rise of . . current during the first major current overshoot for these transients will not exceed 20 mA/µs. Transient current measurements shah be made with an instrument whose bandwidth is at least 1 MHz.

Conducted Emissions on the +10 Volt Interface Bus

Load Current Ripple

The peak to peak amplitude of the steady state load current ripple shall not exceed 5 mA. The fundamental frequency of load current ripple does not exceed 2.5 MHz.

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Inrush Current Rate (Load Current Rate)

The rate of change of load current shall not exceed 20 mA/µs.

Inrush Current (Transient Load Current)

There will be a momentary maximum 10 mA load whenever an incoming command pulse activates a command relay. The pulse shall last for the duration of the command pulse.

Test methods CEO1 and CEO3 are used in accordance with § 4.3.3. An oscilloscope with a current probe (D.C. to 30 MHz minimum bandwidth) may be used in lieu of the EMI meter specified by the test method.

4.3.1.1.2. METOP Requirements

For instrument characterisation only. METOP assumes compatibility of the instrument with these requirements.

For the +28 V Main Power Bus, the fundamental frequency of load current ripple shall not exceed 100 kHz.

Conducted emission in the frequency range 30 Hz to 9 MHz, which may appear on +28 V Main Bus positive and return leads in differential and common mode, shall be within the maximum specified levels **of the** Figure 4.3.1.1-1.

Note : The maximum frequency of 50 MHz has been reduced to the highest frequency (+ 9 harmonics) used by the instrument.

The Common Mode CE requirement is a specific METOP requirement.

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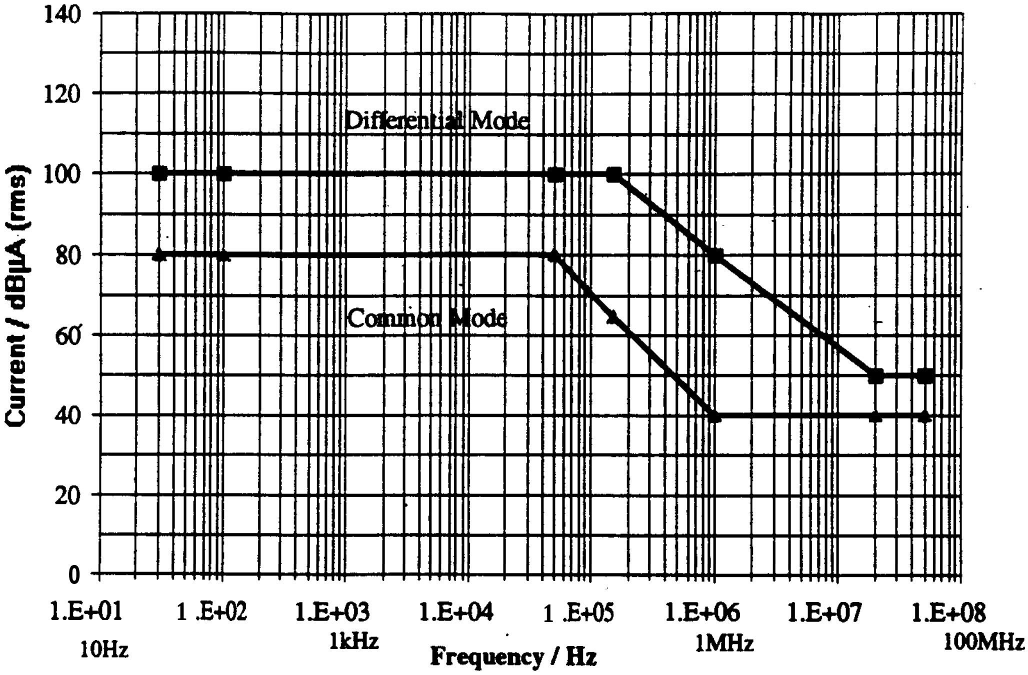

*Fig. 4.3.1.1-l : Conducted Emission Limit, NB, **DM,** CM, 28V Reg. Power **Leads, PLM Instrument***

43.13. Conducted Susceptibility

Frequency Domain

The instrument shall operate without &graded performance in the presence of sinusoidal noise coupled into the power lines between the frequency range 30 Hz and 150 kHz:

+28 V Main Bus	injected Voltage.	300 mVpp
+10 V Interface Bus	injected Voltage'	100 mVpp

The test shah be conducted according methods CS01 and CS02 of AD4. The test method CS01 applies for the frequency range of 30 Hz to 50 kHz and test method CS02 applies to the frequency range of 50 kHz to 150 kHz. The scope of test shall be in accordance to § 4.3.3.

Time Domain

The instrument shall operate without degraded performance when subjected to a series of transient pulses, 10 µsec in width and PRF of 10 Hz applied to the power lines for 10 min. :

+28 V Main Bus	spike level	+10 V / -12 V (tbc)
+ 10 V Interface Bus	spike level	+1 V / -1 V

The test shall be conducted according methods CS06 of AD4. The scope of test shall be in accordance to § 4.3.3.

Special METOP Requirement

For instrument characterisation only. METOP assumes compatibility of the instrument with these requirements.

In addition to above requirements, the AVHRR/3 will experience a common mode sinusoidal noise 300 mV_{pp} in the frequency range 100 kHz and 50 MHz. The noise will be injected between :

the +28 V main bus return line and unit housing, according to Figure 4.3.1.2-1

and the + 10 V interface bus return line and unit housing, according to Figure 4.3.1.2-2

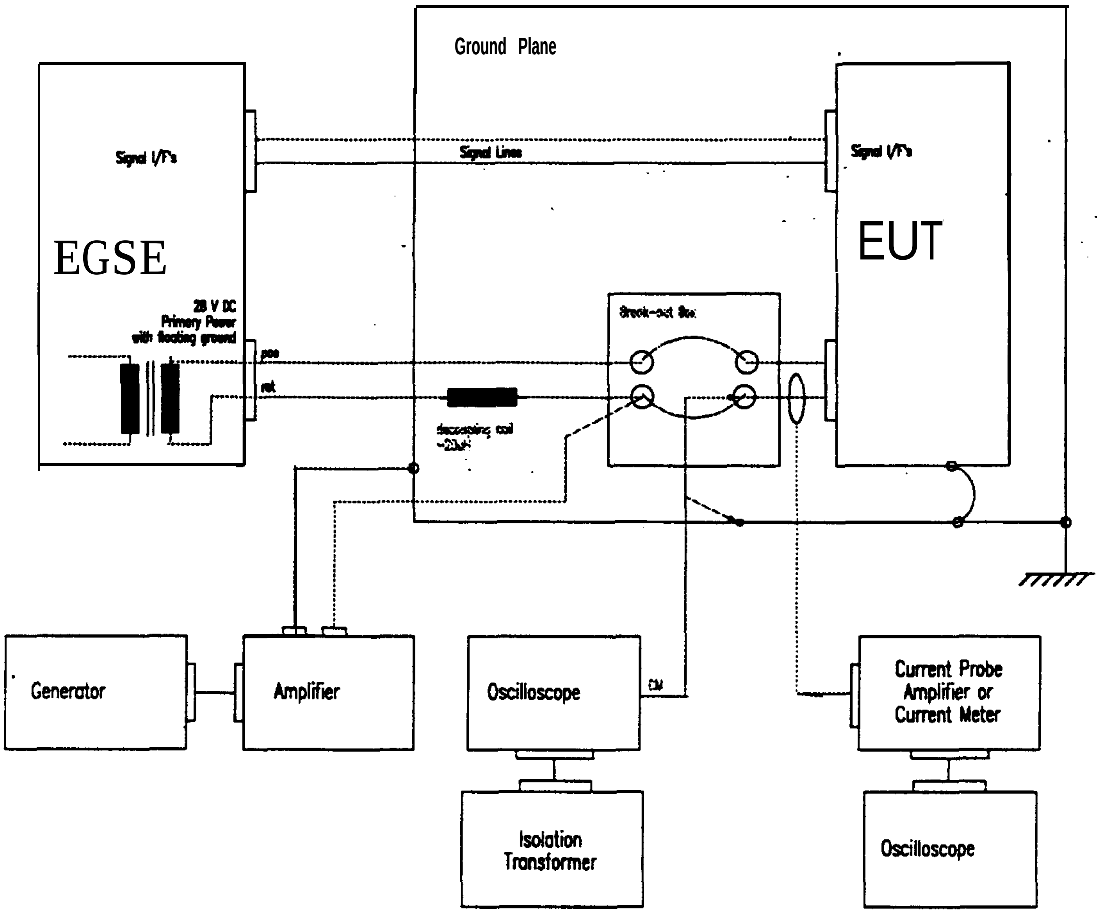

Fig. 4.3.1.2-1: *Common Mode Noise Test on the* ***+28*** *V Main Bus*

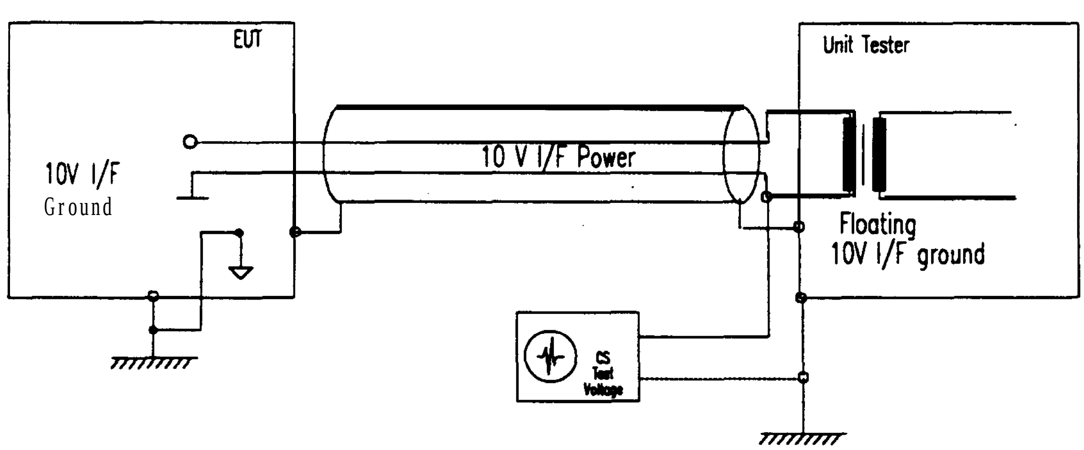

Fig. 4.3.X.2-2 : Common Mode Noise Test on the + ***10*** *V* ***Interface*** *Bus*

43.13. Radiated Emission

4.3.1.3.1. Mil-Std-RE02 Requirements

Broad-band and Narrow-band radiated emission measurements shah be made over the frequency range of 14 kHz to 2 GHz in accordance with Mil-Std 461/462 RE02 requirements. For the discrete ADCS and SARP-3 sensitive bands listed below, broad-band noise and'discrete signals shall not exceed -60 dBm when tested in accordance with the methods of § 4.3.1.3.2 below.

59.458 MHz ± 0.5 kHz	60.100 MHz ± 0.5 kHz
141.360 MHz ± 0.5 kHz	142.900 MHz ± 0.5 kHz
282.733 MHz ± 0.5 kHz	285.813 MHz ± 0.5 kHz
371.921 MHz ± 0.5 kHz	375.972 MHz ± 0.5 kHz
624.925 MHz ± 0.5 kHz	631.730 MHz ± 0.5 kHz
743.841 MHz ± 0.5 kHz	751.944 MHz ± 0.5 kHz

4.3.1.3.2. SARR, SARP-3 and ADCS Receiver Channel Guard Limits

Emission measurements shall be made in accordance with Mil-Std-461/462 RE02 with the EMI meter replaced by a MITEQ preamp (AU-2A-0550 or equivalent) and a spectrum analyzer (HP 8566a or equivalent). The instrument under test and the associated clock and control signals shah have power applied and the difference in the analyzer levels shall be noted for both white noise and spurious signals.

The test antenna shall be tuned to the centre of each of the four bands below. Prior to making the actual measurements, the test antenna shah be demated and the cable terminated in 50 ohms. The noise floor of the equipment shall be verified to be below the specified maximum level for each measurement level. A guideline for establishing the resolution bandwidth is 100 Hz for both the -150 and -145 dBm levels, 1 kHz for the -125 dBm levels and 3 kHz for the -100 dBm levels. The specified maximum radiation limits for all discrete signals and noise power are listed below.

Frequency range (MHz)	Radiation Limit (dBm)	E-field Limit (dB µV/m) For Reference Only	Notes
118.00 - 120.000	-100	18.9	121.5 MHz
120.000 - 121.450	-125	-6	121.5 MHz
121.450 - 121.485	-145	-26	121.5 MHz
121.485 - 121.515	-150	-31	121.5 MHz
121.515 - 121.550	-145	-26	121.5 MHz
121.550 - 123.000	-125	-5.9	121.5 MHz
123.000 - 125.000	-100	19.2	121.5 MHz
236.000 - 240.000	-100	24.9	243.0 MHz
240.000 - 242.925	-125	0	243.0 MHz
242.925 - 242.975	-145	-20	243.0 MHz
242.975 - 243.025	-150	-25	243.0 MHz
243.025 - 243.075	-145	-20	243.0 MHz
243.075 - 246.000	-125	0.1	243.0 MHz
246.000 - 250.000	-100	25.3	243.0 MHz
385.100 - 401.100	-100	29.4	406.05 MHz
401.100 - 405.900	-125	4.5	406.05 MHz
405.900 - 406.000	-145	-15.5	406.05 MHz
406.000 - 406.100	-150	-20.5	406.05 MHz
406.100 - 406.200	-145	-15.5	406.05 MHz
406.200 - 411.000	-125	4.6	406.05 MHz
411.000 - 425.000	-100	29.9	406.05 MHz
396.000 - 401.500	-125	4.4	401.65 MHz
401.500 - 401.600	-145	-15.6	401.65 MHz
401.600 - 401.700	-150	-20.6	401.65 MHz
401.700 - 401.800	-145	-15.6	401.65 MHz
401.800 - 406.000	-125	4.5	401.65 MHz

4.3.1.3.3. METOP Requirements

For instrument characteaisation only. METOP assumes compatibility of the instrument with this requirement

The radiated emissions in the frequency range 14 kHz to 2 GHz shall not exceed the limit given in Table 4.3.1.3-1.

Frequency Range	E-Field Limits (dBµV/m) TBC_{MET}	Remark
10 kHz ... 2 GHz	+ 50	Covered by Mil-Std 461/462 RE02 *
2 GHz ... 40 GHz	+ 70	

*** : The requirements of Mil-Std 461/462 RE02 are more stringent than the METOP RE** limits

Table 4.3.1.3-I : RE-E- Field Limit (NB, AC, Electrical Fields)

Radiated emissions in the METOP payload and system receiver channel guard bands shall not exceed the limits &fined here below :

Frequency Range (MHz)	Radiation Liit (dBm)	E-Field Level (dBµV/m) TBC_{MET}	Remark
1217 - 1257	N/A	+ 21	GRAS
1565.- 1614	N/A	+ 23	
205 1.9 - 2055.0	N/A	+ 9	SBS
5254.7 - 5255.3	N/A	+ 24	ASCAT
400-500	N/A	+ 20	Applies during launch only to
5450 - 5825	N/A	+ 61	active circuits of AVHRR/3

Table 4.3.1.3-2 : Radiated Emission Notches for AVHRR/3

4.3.1.4. Radiated Susceptibility

The instrument will experience a radiated electric field of 1 Vrms/m for frequencies between 14 kHz and 1 GHz, and 2 Vrms/m for frequency between 1 GHz and 18 GHz. The test shall be done with at least 7 discrete frequencies / decade. The radiated E-Field shall be amplitude modulated by a sine wave at 1 kHz with a modulation depth of 50 %.

The test method is defined in § 4.3.3.

In addition, the instrument will be exposed to the following levels :

Frequency	Level TBC_{MET}	Modulation	Source Unit
5.25 GHz	40 Vrms/m	Pulse width = 8.22 ms, chirp rate = -50 kHz/ms, PRF = 4.94	ASCAT
		Pulse width = 10.32 ms. chirp rate = ±24 kHz/ms, PRF = 4.94 Hz	
7.8 GHz	8 Vrms/m	Pulsed 35 MHz PRF, duty cycle 50%	XBS
1.7013 GHz	20 Vrms/m	Pulsed 2.25 MHz PRF, duty cycle 50%	HRPT
468 MHz	14 Vrms/m	Pulsed 1 kHz PRF, duty cycle 50%	A-DCS
137.1 MHz	28 Vrms/m	Pulsed 38.25 kHz PRF, duty cycle 50%	LRPT
1.5445 GHz	7 Vrms/m	FM, 400 kHz peak deviation modulation index M=1	SARR
2.230 GHz	10 Vrms/m	Pulsed 4 kHz PRF, duty cycle 50%	S-Band Downlink

4.3.2. EMC Analysis

The EMC of the AVHRR/3 shall be characterised by test and test discrepancies will be described by the Instrument Supplier. METOP will further assess the impacts on METOP performance.

Magnetic Moments

The magnetic moments shall be determined by analysis or test.

4.3.3. EMC Tests

EMC tests shall be performed in accordance with MIL-STD-462C.

Compliance with EMC requirements shall be demonstrated on all models delivered to METOP.

The Radiated Emission tests are applicable'on all models delivered to METOP.

The Conducted Emission tests are applicable only on the first instrument model delivered to METOP.

4.4. ELECTRICAL FUNCTIONAL VERIFICATION

In general, the test which are described **here** below are performed to ascertain the instrument functional performances and culminate with the instrument **calibration.**

As regards the tests performed after delivery, they are described in § 5 and mainly deal with instrument health checks performed both at ambient and in **thermal** vacuum environment.

4.4.1. Electrical **Interface Tests**

In general, throughout the instrument build-out, every interface is thoroughly checked to ensure the compatibility, the adequacy of the electrical interfaces, in propagation **from** the sensor output / input up to the instrument electronics outputs to the spacecraft on-board equipment, for the basic circuitry and signals : **power,** measurement **data,** housekeeping **data,** commands, clocks, sampling signals...

From a system point of view, the essential step is' the measurement of the spacecraft interface signals and characteristics. The operational mode of the spacecraft system shall be simulated to ascertain interface adequacy : special attention is to be paid for the command and acquisition timing and circuit loading should be representative of the on-board characteristics.

4.4.2. Functional Test

It is the sole responsibility of the Instrument Supplier to **define** and **verify** the proper functions of the instrument prior to delivery to **METOP.** This type of tests are tailored to the specific instrument function verification **and** they serve as instrument health checks that are performed routinely throughout the insuument development programme.

A subset of these tests will constitute later the core of the system testing when the instrument is integrated **on-board** the PLM.

4.4.3. **Performance** Test

It is also the sole responsibility of the Instrument Supplier to define and **verify** the ultimate mission performances of the instrument prior to delivery to **METOP**. This type of tests are tailored to the specific instrument **performances** and they are achieved ultimately with the instrument calibration which requires a rather sophisticated and controlled test set-up.

A subset of these tests may later constitute the system performance test with a **reduced** on-ground set-up. A go / no-go approach is preferred at system level **(PLM** and **Satellite),** due to the complexity of the test set-up and the **AIT** schedule limitations.

Calibration

It is the sole responsibility of the Instrument Supplier to calibrate the instrument prior to delivery to **METOP**. Re-calibration, if deemed necessary, will also be **under** the responsibility of the Instrument Supplier. The calibration data shall be made available on-request for the **preparation** of the system integrated instrument performance test.

APPENDIX : INSTRUMENT ACHIEVED QUALIFICATION STATUS

Vibration Test : High Level Sine Sweep

The instrument has not been subject to a High Level Sine Sweep test.

Vibration Test : Sine Burst

The instrument has been subject to the following Sine Burst environment :

	Sine Burst Test Levels
QUAL	**All three axes** Test level : 15.55 g **Frequency : 35 Hz** **Duration** : 0.5 second
ACC	**All three axes** Test level : 12.40 g Frequency : 35 Hz (tbc) Duration : 0.5 second

Vibration Test : Random Levels

The instrument has been subject to the following random environment :

Random Vibration Test Levels			
	All Three Axes		
QUAL. & ACC.	**Frequency Range (Hz)**	**Power Spectral Density g^2/Hz**	**Slope (dB/Oct.)**
	20 to 60		**+8**
	75 to 150	0.04	
	1000 to 2000		-3
	Overall level : 8.12 g rms Duration 1 min per axis		

5. INSTRUMENT GSE AND AIV INTERFACES

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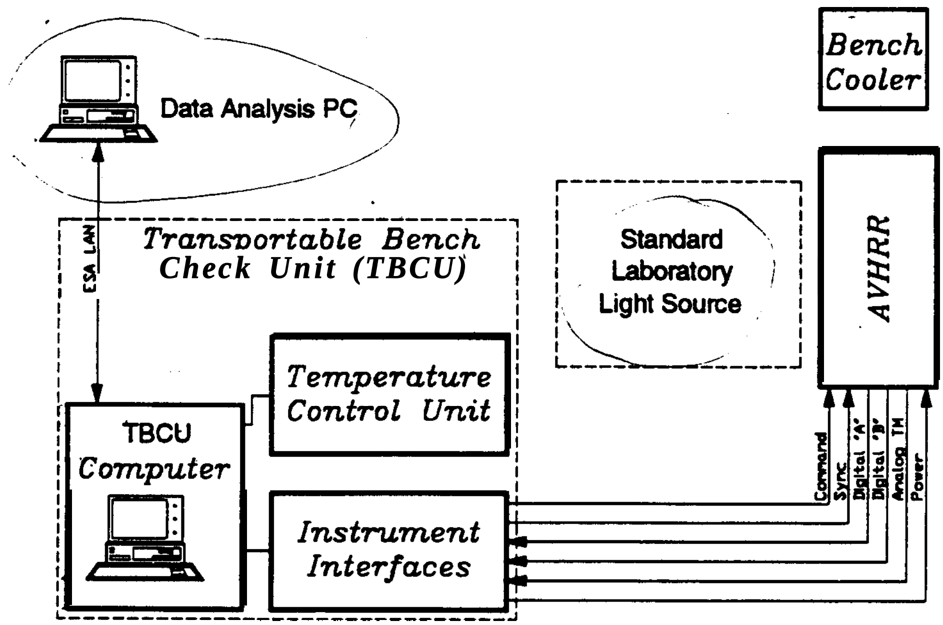
5.1. INSTRUMENT GSE DESCRIPTION

5.1.1. Bench Test Equipment

The Instrument Supplier will provide all test equipment required for bench test of the AVHRR/3. This equipment shall include equipment used to power and command the AVHRR/3.

Figure 5.1.1-1 provides an overview of the bench test set-up.



Note : the Temperature Control Unit of the TBCU is not used during bench testing.

See also AD15

Figure 5.1.1-I : Bench Test Set-Up

The AVHRR/3 GSE consists of the following items :

a) A Transportable Bench Check Unit (TBCU)

b) Lifting fixture

c) Bench cooler (AD14)

The TBCU contains the power supplies for the instrument and all interfaces to the AVHRW3. A dedicated network card will be installed for communications with a workstation located in US (see § 5.2.4.6.).

For bench testing at ambient a bench cooler will be mounted to the instrument. The relevant mounting interface is the instrument radiant cooler vacuum housing. This device brings the AVHRR/3 radiant cooler temperature down to approximately 100 K. There will be a stand alone controller on the bench cooler that will not interface to the TBCU.

A standard laboratory light source will be available for testing the **AVHRR/3** under ambient pressure conditions, with the bench cooler attached to the instrument. The source consists of a standard laboratory integrating sphere and is provided by **METOP. The** stimulation of the visible channels will be performed by the integrating sphere described in the standard equipment list below (as a back-up, a scene light can be used).

The following pieces of standard equipment will be supplied by **METOP for** use during bench tests of the **AVHRR/3** instruments :

1. **Oscilloscope**
2. Digital Voltmeter
3. Standard laboratory integrating sphere **(TBD_{AVH})**.
   This item could be identical to the one **for HIRS/4.**
4. General mechanical tool set and support.

51.2. GSE for Integration with PLM OCOE

5.13.1. Ambient Testing

Under ambient conditions, the same set-up is used as for bench testing except that the instrument is operated via the PLM EGSE. For further details see § 5.2, Figure 5.1.1-I shows the configuration for instrument level testing (bench test) and Figure 5.2.1.1-1 for PLM level testing. Sufficient clearance, accessibility of the instrument coolers with the bench cooler needs are **TBC_{MET}**.

5.1.2.2. Thermal Vacuum Testing

For thermal vacuum testing, the following targets will be used (provided by the Instrument Supplier) :

- Space clamp target (AD12)
- Radiant cooler target **(TBC_{MET})**

The space clamp target will be **used** to provide a **"0"** radiance reference level for the **AVHRR/3.** It will **be cooled with** LN2 (80 deg. **K)** to approximately 100 deg. K **(TBC_{MET})**. The set-up of the space clamp target for **T/V** testing is outlined in **AD13.**

In thermal vacuum tests, a vacuum chamber shroud panel cooled with LN2 (80 K) will be used as the radiant cooler target. This target will provide the proper thermal inputs for the operation of the radiant cooler. The distance and size of the shroud panel with respect to the instrument patch shall be such that the patch can be adequately cooled (approximately 115 **K,** see RD9). This temperature is required to obtain useful data to check **IR** detector **aliveness.**

No other external target is baselined for use during TV testing. Back-up consists in Instrument Supplier provided radiant cooler target (RD 10). to be **mounted** in front of the instrument radiant cooler.

Only me Instrument Supplier provided targets are controlled by the TBCU.

The TBCU will carry out the instrument digital A data processing. The interface between the **AVHRR/3** TBCU and the **METOP** N-DAPB shall be via a LAN as defined in § 5.2 below.

5.1.3. Mechanical Ground Support Equipment

Support [illegible]
Drill template are [illegible]

The Instrument Supplier shall provide a **handling** fixture **which** can be used for safely lifting and **transporting the AVHRR/3.** The **handling fixture** shall be **capable of mounting** the instrument when the **spacecraft** is either in vertical or **horizontal position.** Provisions **shall be** made to lift with a **crane.** **(Drawing TBD$_{INST}$)**

Need for drill template is **TBD$_{MET}$**.

Containers shall be supplied for shipping and storage of each **AVHRR/3** deliverable **instruments,** to provide for all storage of instruments at the **METOP** integration and test **sites. The instrument** storage containers will be sealed and back-filled **with** dry N_2 to one atmosphere.

Scan cavity and radiative cooler protective covers and **connector** dust caps shall be delivered with each instrument Installation and removal procedure shall be in accordance with **TBD$_{AVH}$.**

5.1.4. Self-Contained Special Test Equipment

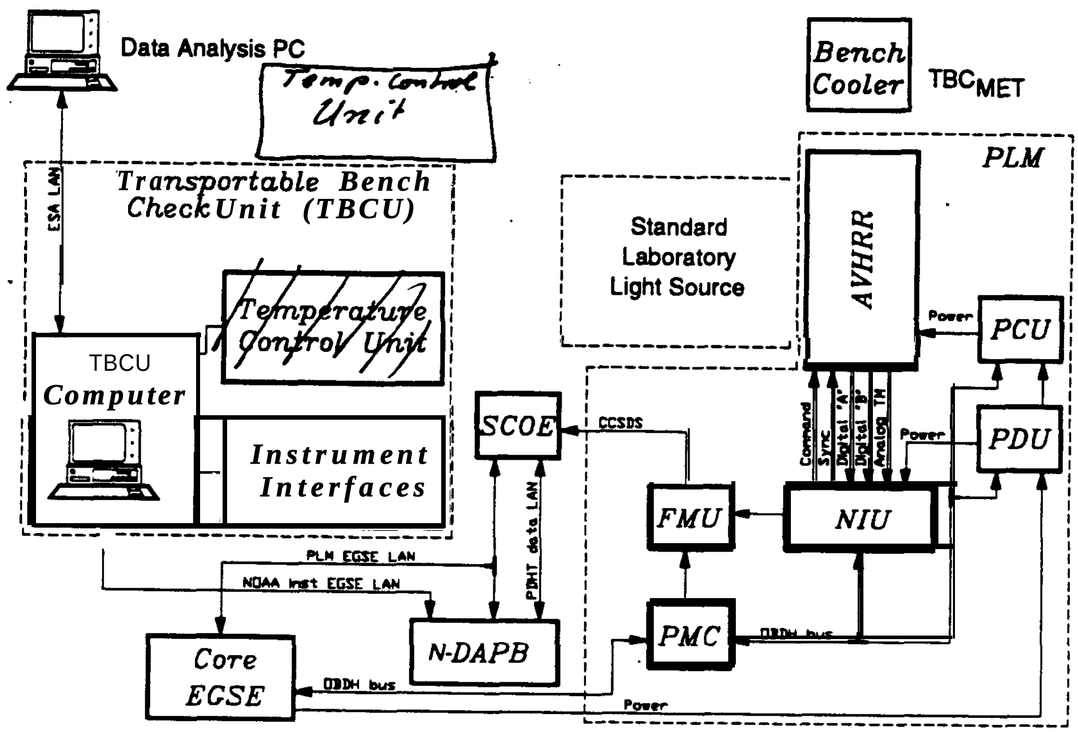
The bench cooler is a stand-alone system : once started, it will automatically maintain the instrument detectors at the proper temperature. The bench cooler has no external electrical interfaces with the **METOP** OCOE.

5.2. INSTRUMENT GSE INTERFACES

5.2.1. Interfaces with PLM OCOE

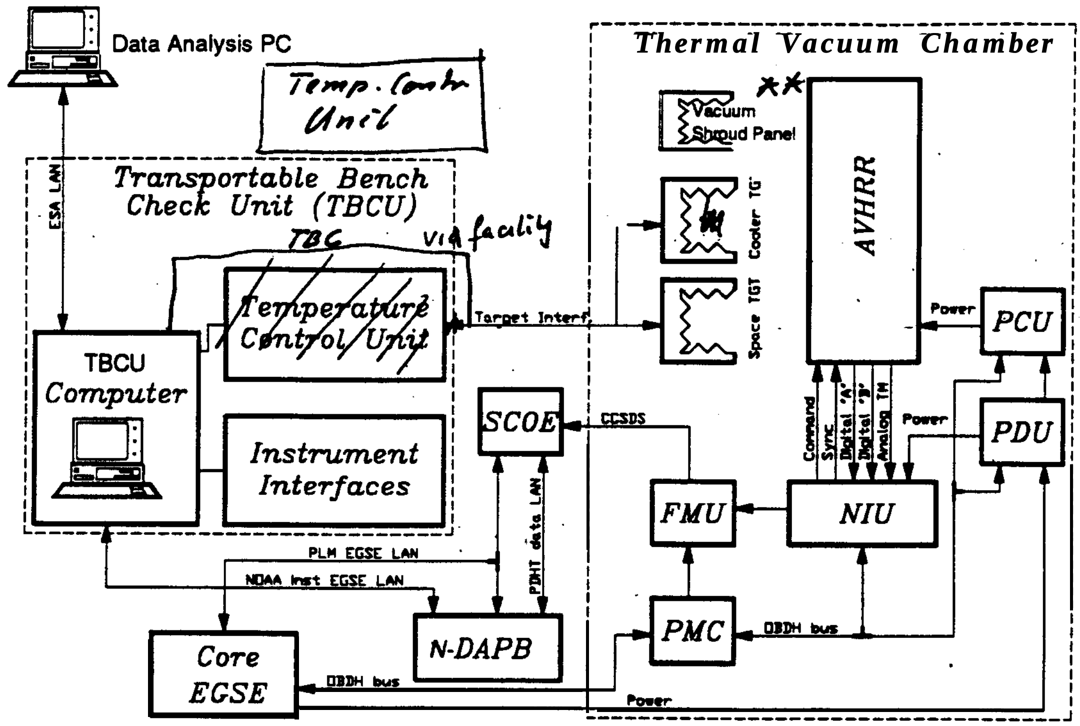
53.1.1. General

The configuration of AVHRR/3 test equipment within the overall check-out equipment for the METOP payload module is shown in Figure 5.2.1.1-1 for the ambient test configuration and in Figure 5.2.1.1-2 for TV testing. In all cases, the only interface between the OCOE and the instrument test equipment will be a LAN connection between the NOAA instrument DAPB (N-DAPB) and the instrument data processing equipment. Details can be found in RD11.



Note : The Temperature Control Unit and the Instrument Interfaces unit of the TBCU are not used during PLM testing at ambient.

Fig. 5.2.1.1-X : AVHRR/3 Test Set-up in PLM Configuration (Ambient)



* ~~Only us a back-~~up TBC
** used as backup.

Note : The Instrument Interfaces unit of the TBCU is not used during TV testing.

Figure 5.2.1.1-2 : AVHRR/3 Test Set-up in PLM TV Configuration

Test set-up in **TB** is $\mathbf{TBD}_{MET}$.

5.2.1.2. Stimulus/Feedback Equipment Interface

5.2.1.2.1. Physical /Electrical Interface

For ambient testing : Not applicable.

The bench cooler is a stand alone system, once started, will automatically maintain the instrument detectors at the proper temperature. The bench cooler has no external electrical interfaces, with the exception of the power source.

The standard light source is also a stand-alone equipment.

For TV testing : Not applicable.

The space clamp target is directly acquired by the ~~TBCU.~~ facility (METOP)
~~If used,~~ The cooler target will be **directly** acquired by the ~~TBCU.~~ facility (Metop)

5.2.1.2.2. Protocol Interface

Not applicable.

5.2.1.2.3. Stimulus/Feedback Data Handling Requirements via the facility

The target temperature dam of all used targets will be acquired and processed in the TBCU. The data shall be formatted into (TBC) standard CCSDS source packets and transferred to the N-DAPB for archiving purpose. No processing of the target temperature data in the N-DAPB is required.

5.2.1.3. Interface with Instrument-Provided Data Processing Equipment

5.2.1.3.1. Physical / Electrical Interface

The AVHRR/3 measurement data shall be made available to the TBCU via a 100/10 Base-T Ethernet LAN interface.

5.2.1.3.2. Protocol Interface

The data sent to the TBCU is the complete source packet as generated by the NIU.

For support of the measurement data processing, AVHRR/3 related housekeeping data, like digital "B" and analog data, as well as a copy of instrument related commands sent to the NIU, can be made available. For all communication between the instrument data processing equipment and the METOP provided N-DAPB, standard CCSDS source packets shall be used as unique protocol data units.

Further details on the protocol are defined in AD10 ~~and AD6~~.

5.2.1.4. Measurement Data Evaluation

5.2.1.4.1. Instrument Measurement Data Format Definition.

The instrument measurement data format is defined in § 3.3. The data is acquired by the NIU in a cyclic manner according to the timing specified in § 3.3. As a consequence , each AVHRR/3 source packet at thc output of the NIU will contain the same data in the same sequence.

The overall source packet layout is defined in Figure 5.2.1.4-l below. The instrument measurement data format as defined in § 3.3 presents the user data space.

PACKET PRIMARY HEADER (6 Octets)							PACKET DATA FIELD		
Packet Identification (2 octets)				Packet Sequence Control (2 octets)		Packet Length (2 octets)	Secondary Header (6 oct.)	Source Data: User Data (12944 oct.)	Source Data: Packet Error Control (2 octets)
Version Number 3 bits	Type Indic. 1 bit	Sec. Header Flag 1 bit	APID 11 bits	Seq. Flag 2 bits	Packet Seq. count 14 bits		Time Stamp	See § 3.3.3.	
16 bits				16 bits		16 bits.	48 bits		16 bits

Figure 5.2.4.1-l : *AVHRR/3* Source *Packet Lay-Out*

Primary Header Field

Packet Identification

The Packet ID Field will follow the following format :

Bit Position	Subfield Name	Set to	Code
0..2	Version Number	'Version 1'	000
3	Type Indicator	'TM' .	0
4	Packet Secondary Header Flag	-	1
5..15	Application Process Identifier (APID)	'AVHRR/3'	103 : day (Channel 3A) 104 : night (Channel 3B)

Packet Sequence Control

The Packet Sequence Control Field will follow the following format :

Bit Position	Subfield name	Set to	Code
0..1	Sequence Flag	'Unsegmented'	11
2..15	Packet Sequence Count	Incremented for each packet	Sequential binary continuous count

Packet Sequence Count is a method of counting the number of packets generated by the application. This significant parameter is a sequential count of the Packet Sequence Control Fields. This field will start with a value of zero and increment to 3FFF (HEX, or 16384). At this point it will roll-over and continue again from zero. The count will re-start from zero after power-on No reset of the count is allowed before reaching 16383.

Packet Length

This field contains a binary number which permits to identify the length of the User Data and Packet Error Control fields. Its value is defined as follows : *number of octets of the Packet Data field - 1.*

Packet Data Field

The Source Data field is split in three parts.

The first part is the Secondary Header which is used for time code information. For AVHRR/3, the time stamp contains the NIU on-board time latched at the leading (rising) edge of the AVHRR Line Synchronization Pulse, corresponding to the start of the scan.

The second part is the area that contains the user data, as described in § 3.3.3.

The third part is the Packet Error Control (PEC) field that consists of a Cyclic Redundancy Checksum (CRC), computed over all the octets composing the packets, except the PEC. The generator of the polynomial is : $G(x) = x^{16} + x^{12} + x^{5} + 1$.

5.2.1.4.2. Reference Data Presentation

For each of the relevant test configurations, i.e. with the light source / bench cooler for functional tests at ambient pressure, there will be a reference data set available obtained from the instrument level check-out. Representativity of ambient conditions reference data set for IR channels is TBD_{AVH}.

For thermal vacuum test, the reference data shall be generated emulating'at instrument 'level the conditions at PLM level.

The instrument GSE software shall be capable of delivering the reference data, obtained during tests at instrument level, on a computer readable medium, in a format that can be imported in the Core EGSE local data base. (TBC)

5.2.1.4.3. Data Comparison Requirements

Actual measurement data from the instrument, including radiometric data, shall be checked against reference data sets, according the requirements of NASA (TBD). ~~The software for making the comparison will be part of the data processing software that will be delivered with the TBCU.~~

5.2.1.4.4. Data Processing Algorithms

All required data processing algorithms shall be incorporated into the software supplied with the instrument TBCU.

5.23. Interfaces with the PLM On-Board Equipment

5.2.2.1. Test Harness and Connectors

Not applicable.

5.2.2.2. Special Test Adapters (T-Junctions, Break-Out Boxes)

AVHRR/3 to PLM avionics interfaces are all via standard sub-D type connectors, therefore no special adapter is needed from the instrument. Connector types are defined in § 3.4.4 and 3.5.4. Connector locations on the instrument are illustrated in interface drawing from § 2.1.4.

The AVHRR/3 instrument is supplied with connector savers.

5.2.2.3. Stimuli Source Configuration /Arrangement Requirement

The bench cooler shall mate to the instrument radiant cooler. The arrangement of the bench cooler to the instrument radiant cooler is TBD_{AVH}.

During bench tests and PLM ambient tests, the METOP supplied light source shall be placed in front of the scan cavity. The exact arrangement is TBD_{AVH}.

During PLM TV testing, the AVHRR/3 target arrangement is as defined in AD13.

5.23. Interfaces with Other PLM GSE

The space clamp target will be attached to the scaffolding in the T/V chamber as per drawing TBD_{MET}. The mounting interfaces are defined in AD12 and AD13.

5.2.4. Interfaces with AIT and Launch Site Facilities

5.4.2.1. Mains Power

The instrument test equipment will be operated from mains power via a METOP-provided isolation transformer with the following output characteristics :

- Voltage : 230 V AC (±10%), 10 A max., single phase
- Frequency : 50 Hz ± 1 Hz
- Power plug standards used within the METOP project for 230 V is DIN 49441/CEE7, power sockets DIN 499440/CEE7

The actual estimated steady state power consumption of the instrument is as follows (@ 230 V) :

- TBCU : 4.9 A TBC_{AVH}
- Bench cooler : 8.0 A

For the **AVHRR/3** GSE, two single-phase isolation transformers are required, one for the bench cooler and one for the rest of the GSE.

5.2.4.2. **Cooling / Thermal Dissipation Requirements**

The AVHRR/3 GSE has no requirement for additional cooling provisions beyond natural convection.

53.43. Purging Gas Requirements

After ambient testing with the bench cooler **connected** and in'operation, when the instrument has been brought back to room temperature, 6 litres of dry GN_2 is required to **back-fill the** radiant cooler vacuum housing in order to avoid condensation on the detectors.

5.2.4.4. GN2 **/ LN2 Supply**

For back filling of transport and storage containers, GN_2 per Fed. **Spec. BB-N-441b** Type 1, Class 1, Grade A or equivalent shall be used.

For bench cooler **purge** valves, GN2 per Fed standard, or equivalent, shall be used.

The LN_2 (80 K) consumption during bench cooler operation is approximately 10 **litres/hour**.

During thermal vacuum target operation, **LN_2 consumption is**

- Space clamp target 10 **litres/hour**
- Radiator target 10 **litres/hour** (back-up)

5.2.4.5. **Test Chamber Wall Feed-Through Panels**

The **TV-chamber** feed-through panels shall provide 2 LN_2 (80 K) ducts for the AVHRW3 space clamp target and 2 LN_2 (80 K) ducts for the radiant cooler target. if used (Note : **The** number of feed-through ducts may possibly be reduced by running some **targets** in series. This approach will need to be proven by analysis)

4 electrical feed-throughs for K-type thermocouples and 14 electrical **PRT's** are needed in the chamber panels. TBD_{AVH} electrical feed-throughs are required for the radiant cooler target heater lines, if used.

5.2.4.6. **Public Data Net Communication Requirements**

The **METOP AIT** and launch site facilities will provide access to a public data network in **order** to enable data exchange with Instrument Suppliers for off-line data evaluation at the **AVHRR/3** Instrument Supplier premises.

As a baseline, the file transfer procedures **(FTP)** via INTERNET will be used, however other TCP **/ IP** application layers via INTERNET and **/** or modem can be used. Requirements are TBD_{AVH}.

5.2.4.7. **Physical Interfaces**

For **set-up** of the bench test equipment an area of 20 m^2 as a minimum shall be provided in a temperature and humidity controlled class 100,000 clean area. See AD15.

5.3. INSTRUMENT GROUND OPERATION REQUIREMENTS

53.1. General

Instrument operational constraints are presented in § 1.4.1. Test procedures may deviate from these.

Instrument modes and in orbit operations are described in § 1.4 and § 1 5 .

AVHRR/3 telecommands are described in § 3.2.2.

For the ground operations, the acknowledgement of the commands by the instrument is done using Analog Housekeeping and Digital B data from the instrument, as described in § 3.2.3.

Conditions for testing

If a solar simulator is used and on, the scanner must be operating.6 + the aperture must be protected by the facility

IR channels shall not be enabled when the radiant cooler is at ambient temperature (IR detector patch not cooled). The Channel 3B Enable, Channel 4 Enable and Channel 5 Enable commands are o&round critical commands.

Automatic function of TDCU (monitoring instrument TM, assessment of performance)

5.3.2. Command and Control Sequences

The testability of the instrument depends on the usage of stimuli and cooler equipment as outlined in Table 5.3.2-l below. Command and control sequences will be implemented in the check-out software of the METOP overall check-out equipment in terms of control files for automated testing. The control files will ensure that the instrument is operated and tested in accordance with the objectives given below. Control files will be coded on the basis of test procedures prepared by the METOP AIT team following inputs from the Instrument Supplier, and checked by the Instrument Supplier.

Control files shali take into account the generic operation requirements given above, and the special requirements for ambient and TV testing given in the following subchapters.

	TEST CONFIGURATION		
	PLM Electrical Test S/L Test **(TBC_{MET})**	**Incoming Inspection** **Pre-Integration** **PLM Electrical Test (TBC_{MET})** **S/L Test (TBC_{MET})**	PLM TV Test
Test objective	**No external stimulus** **No** cooler **Ambient pressure**	**Standard lab. light source.** **Bench Cooler** **Ambient pressure**	~~**Only internal targets**~~ Space clamp target ~~**Cooled Shroud Panel**~~ Radiant cooler target. **TV Cond.**
Command Handling	**Verification** of **command acceptance** andexecution (Note **1**)	Verification of command **acceptance** and execution	
HK **Telemetry Check**	Monitoring of HK telemetry data against **pre-defined** limits and change of commands		
Scan Motor Cheration	Functional check		
Visible **Channel** Data	Present of data ~~**Coarse calibration check against data baselined at instrument level**~~	Coarse calibration check against data baselined at instrument level	Noise **performance data** and coarse calibration against data baselined at instrument level (view of chamber interior)
Infrared Channel Data	**Not** applicable (not authorized)	Presence of data and noise performance check against data **baselined** at instrument level	Presence of data and noise **performance** check against data baselined at instrument level

Note 1: excluding the commands that switch the **IR** channels on **or** involve the IR channels.

Note 2 *: the TB* test is not dealt with in this table since it is not relevant to **instrument** performance test.

Table* 5.3.2-I : *Test Objectives Versus Test Configurations

53.2.1. Ambient Conditions

Operation of the instrument under ambient conditions is subject to the following constraints :

1. IR detector temperature, as determined from the extended patch temperature telemetry, should never exceed 35 deg. C.
2. Patch temperature should be maintained to prevent condensation.
3. IR channels shall not be activated with no bench cooler'or equivalent. [1]

Warning : Door should be manual **restrained so that** it does not impact the stops during testing (see § 56.1).

Procedure to open the radiant cooler door with the bench cooler attached is TBD_{AVH}.

Note : during bench cooler operations an exhaust line or filter, provided by METOP, shall be installed on the bench cooler vacuum exhaust.

The normal operation mode and switch-on sequence for ambient pressure and temperature operation is as follows (these procedures are intended as general guidelines ; the procedures will be specified in the operation manuals supplied with the GSE):

(1) initial Sequence (to assure that each instrument section is reset properly) (tbc)

1) Patch Control OFF
2) Channel 1 DISABLE
3) Channel 2 DISABLE
4) Channel 3A DISABLE
5) Channel 3B DISABLE
6) Channel 4 DISABLE
7) Channel 5 DISABLE
8) Cooler Heat OFF
9) Earth Shield Disable
10) Voltage Calibrate OFF
11) Electronics/Telemetry OFF
12) Telemetry NOT Locked On
13) Scan Motor / Telemetry OFF

(2) Switch-on Sequence (tbc)

1) Pump down the bench cooler to a pressure of 10^{-5} Torr (= 1.33 10^{-5} mbar)
2) Go to **AVHRR/3** Off Mode

---

[1] **Remark** : in case **IR channels are activated at ambient without cooling, there is no damage to the AVHRR/3 as soon as the patch temperature telemetry is below 35 deg. C : this limits the activation of IR channels to maximum 2 minutes starting from nominal temperature range.**

3) Turn on cooler heater (decontamination), maintain for 6 hours min. Defector temperature should be monitored and the heater turned off if detector reaches 35 deg. *C.*
4) After 0.5 hours, turn off cooler heater. Cool until patch reaches operating temperature.
5) Electronics/Telemetry ON
6) Turn on channels 1 through 5. Allow time for patch temperature to stabilise before, taking measurements.
7) Patch Control ON
8) Earth Shield DISABLE

Remark : With no bench cooler, use-only steps #2, 5, 6 (for channels 1, 2 and 3A only), 7 and 8.

(3) Switch-off Sequence TBC

1) Disable all channels **(Off Mode)**
2) Turn on instrument outgas heater:
3) Turn on bench cooler heater
4) Bring bench cooler shroud to room temperature, being sure that this temperature does not exceed IR detector temperature.
5) Wait until all temperatures reach room temperature (note : patch may be 30 deg. C)
6) Cooler Heater OFF
7) Scan M&or/Telemetry OFF
8) Patch Control OFF
9) Telemetry NOT Locked ON
10) Back fill to ambient pressure, using dry N_2.

Remark : With no bench cooler, use only steps #1, 6, 7, 8 and 9.

Switch ON/OFF SEQUENCE is defined in [illegible]
NO IR channel activation

5.3.2.2. Thermal **Vacuum Conditions**

Operation of the **instrument** in thermal vacuum is subject to the following constraints :

1. IR detector temperature, as **determined** from the extended patch temperature telemetry, should never **exceed** 35 deg. C.

2. Patch temperature should be maintained to prevent condensation.

The cooler door will normally be closed at the start of **pump-down.** When the pump-down is completed the outgassing heater must be turned on before starting to cool the radiant cooler shroud and target.

24 hours after the cooler heater is turned on and when the cooler target is **fully** cooled down, the cooler door may be opened. When the door is open the **operating** mode command sequence may be sent.

The normal operation mode and switch-on sequence for vacuum and end of vacuum operation is as follows (these procedures are intended as general guidelines **; the procedures will be specified** in the operation manuals supplied with the GSE) :

(A) Initial Sequence (to assure that each instrument section is reset properly) TBG

1) Patch Control **OFF**
2) **Channel** 1 DISABLE
3) Channel ‘2 DISABLE
4) Channel 3A DISABLE
5) Channel **3B** DISABLE
6) Channel 4 DISABLE
7) Channel 5 DISABLE
8) Cooler Heat **OFF**
9) Earth Shield Disable
10) Voltage Calibrate **OFF**
11) **Electronics/Telemetry OFF**
12) Telemetry NOT Locked On
13) Scan Motor / Telemetry **OFF**

***(B)** Beginning of Vacuum Test* TBC

1) Pumpdownthechambertoapressureof 10^{-5} **than** 10^{-5} **mbar and confirm**
2) Turn on instrument electronics and scan motor
3) Disable all channels.
4) Turn on cooler heater (decontamination) and confirm
5) Cool shroud (or cooler target) to operating temperature
6) After 48 hours, turn off cooler heater. Detector temperature should be monitored and the heater turned off if detector temperature reaches 35 deg. C.
7) Open cooler door.
8) Turn on channels 1 through **5**.

(C) End of Vacuum Test(TBC)

1) Disable all channels. **(Off Mode)**
2) Turn on cooler heater (decontamination).
3) Bring shroud to room temperature, being sure that this temperature does not exceed IR detectortemperature.
4) Turn off electronics and scan motor.
5) Back fill to ambient pressure, using dry N2.

Note : it is recommended that the cooler heaters be turned on during warm-up to prevent the cooler from becoming contaminated.

Verification is needed that scan motor can freely rotate

5.33. Hazards / Precautions

Assure adequate clearance exists for cooler door deployment. The cooler cover shall be removed prior to deploying the cooler door.

Persons handling the instrument must wear ESD dissipating smocks, caps and gloves as a minimum.

Proper caution should be observed in maintaining clearance around the instrument when removing the handling fixture.

The instrument is an ESD sensitive device.

Remove connector savers before restoring the instrument into its shipping container.

5.4. INSTRUMENT ACCEPTANCE AT AIT SITE

5.4.1. Unpacking/Packing and Handling Requirements

For all instrument handling and mounting the delivered handling flxture shall be used. The instrument shall be handled only with anti-static gloves.

5.4.2. Incoming Inspection

The incoming inspection starts as soon as instrument equipment arrives at the integration site. After unpacking under cleanroom conditions, the following will be carried out :

- Visual Inspection of Instrument and GSE
- Dimensional / flatness check
- Units Weighing
- Bench Testing

Bench Level Tests

Prior to installation and to the PLM and electrical integration with PLM avionics, the instruments shall undergo a bench level check-out to demonstrate aliveness and instrument readiness for the subsequent system level AIT activities.

The instrument will be set up on a test bench (e.g. a table with conductive surface) and shall be connected to the instrument test equipment and bench cooler. Then a series of checkout activities shall be carried out as required to validate the instrument readiness (including visible and IR channels).

The test equipment (e.g. a portable bench test equipment) shall be provided by the Instrument Supplier and shall reside at the PLM and satellite AIV sites to support instrument troubleshooting, if necessary. Operation of the instrument and its bench test equipment is done by the Instrument Supplier team in accordance to the following instrument-provided procedures and manuals :

Incoming test procedures (incl. pass / fail criteria) : TBD_{AVH}

Test equipment handling and assembly procedures : TBD_{AVH}

The test configuration is as per Table 5.3.2-l.

5.43. Instrument Self-Compatibility Test

N/A

5.5. INTEGRATION ON METOP TBC

5.5.1. Pre-Integration

Prior to the installation in the PLM, the instrument will be pre-integrated with the NIU and parts of the NIU test equipment as well as the power conditioning unit. The corresponding set-up of on-board units and ground support equipment is shown in Figure 5 .5.1- 1.

The purposes of the pre-integration activities is to verify electrical interfaces between instruments and NIU and PCU, to develop instrument specific test sequences, and to refine and validate the DAPB operation separately from the PLM level AIT in order to reduce the overall integration time.

The activities carried out with the instruments in the NIU pre-integration are electrical integration and instrument IST's as described in § 5.5.3 below.

The physical arrangement of the instruments during pre-integration will be on desks with conductive surface. The interconnection to the NIU and PCU is accomplished with a METOP provided test cable harness. Pre-integration activities are done in a clean room environment as required.

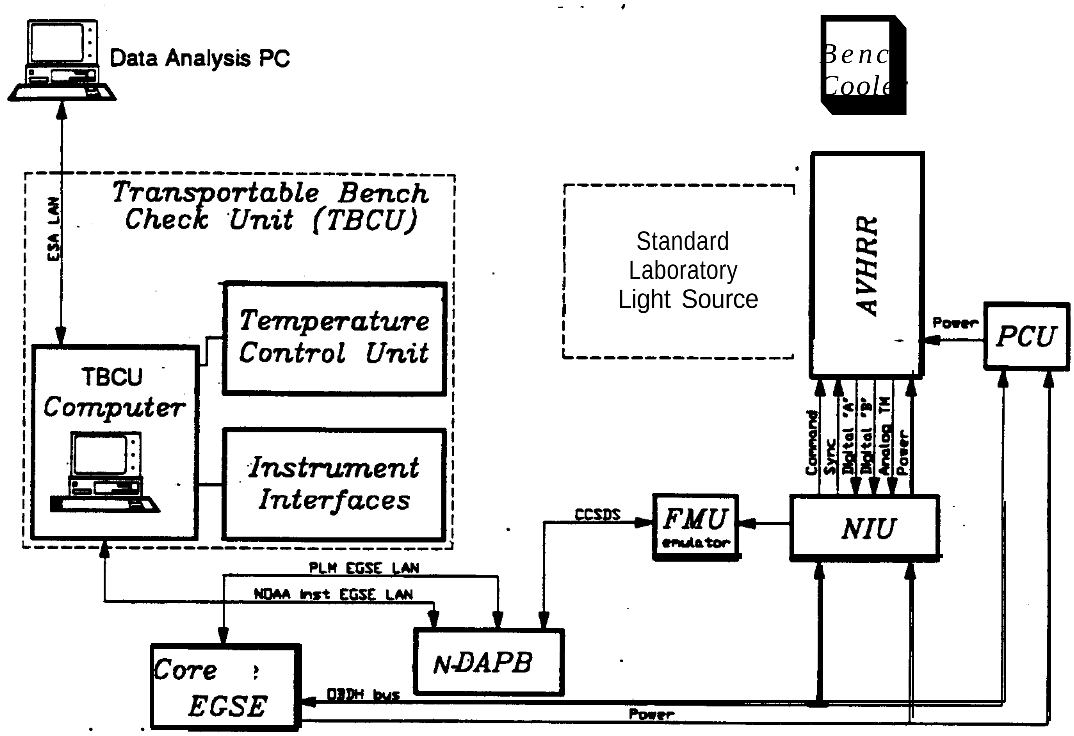
After completion of the pre-integration activities the instruments together with the NIU and the PCU will be installed in the payload module. An abbreviated electrical integration and part of the IST's are then repeated.

The test configuration is as per Table 5.3.2-l.

5.5.2. Mechanical / Thermal Integration

The instrument mechanical / thermal integration includes the following activities :

- Physical installation to associated PLM panels according to agreed procedures including thermal insulation/filling and other
- Mechanical adjustment as required
- Installation of thermal fillers / insulators as required
- Mounting of thermal blankets
- Bonding measurement between equipment case and PLM structure
- Mechanical integration of pre-integrated instrument panels to the payload carrier structure



Note : The Temperature Control Unit and the Instrument Interfaces unit of the TBCU are not used during PLM resting.

Figure 5.5.1-1 : AVHRR/3 Test Set-Up in Pre-integration Configuration

5.5.3. Electrical Integration and IST's

The electrical integration of the instrument is done after the integration of its GSE. The purpose of the electrical integration of the instrument on-board equipment is twofold : to verify that the interfaces between the instrument and the PLM avionics are as specified, and to accomplish instrument operation commissioning within the PLM environment.

The following activities are carried out for electrical interface verification :

Instrument Grounding / Isolation Check : before *mating any connector with the* system harness, it is verified that designated ground&g pins are properly terminated to chassis, and other connector pins are isolated.

Safety Check : it is verified before connecting the system harness, that there is no unexpected dangerous voltage, nor a short to chassis ground

T-Junction Tests : instrument *connectors are mated with the* PLM harness one by one via T-junctions, which allow measuring signal 'characteristics. Power connectors are mated first, followed by command interface connectors and telemetry interface connectors. The instrument is operated from the PLM Command & Control Block (CCB) by sending commands manually. Essential signal parameters such as rise/fall times, signal levels, signal timing, inrush currents and power consumption are recorded and compared against expected (ICD) values.

The instrument electrical integration procedures will be prepared by the PLM AIT team on the basis of inputs from the Instrument Supplier, and reviewed and supported by the Instrument Supplier.

An instrument IST will follow the verification of the instrument interfaces. The purpose of this test is to perform. a reference instrument check-out in the overall system environment_

The instrument will be operated in all relevant modes including degraded modes and redundancy activation. Full instrument operability validation is achieved in the IST. This comprises both the on-board equipment and the ground support equipment and check-out software. It is to be noted that the check-out software,' at least the AIT data base with the TM/TC parameter definitions will be re-used during mission operation. Instrument specific control files will be refined and validated in the IST.

In addition to the above objectives, the IST serves to produce reference data sets for the subsequent environmental and system function test programs.

The test configuration is as per Table 5.3.2-1.

Operations of the instrument with the bench cooler attached would allow the checking of the IR detectors. This test set-up requires free access of the bench cooler to the radiative cooler of the instrument with neighbourhood instruments (HIRS/4, IASI) adjacent. Feasibility of this set up is presently TBC_{MET} due to compatibility between bench cooler physical envelope and PLM configuration.

5.5.4. Integration of GSE

5.5.4.1. Integration of GSE with the Flight Equipment

Not applicable.

5.5.4.2. GSE Integration with PLM OCOE

EGSE integratio

the instrument-provided test equipment shall be connected with the METOP-provided PLM EGSE. Generally, EGSE integration basically consists of an end-to-end communication check to demonstrate full operability under control of the Command and Control Block (CCB).

The instrument GSE integration procedures will be prepared by the PLM AIT team on the basis of inputs from the Instrument Supplier, and reviewed and supported by the Instrument Supplier.

5.6. INSTRUMENT OPERATION CONSTRAINTS DURING PLM AND SATELLITE SYSTEM TESTS TBC

5.6.1. System Environmental Test Levels

Ground operation of the radiant cooler door :

During all METOP integration and test programme, the solenoid release shall be limited to a total of :

1 time without shock damping

unlimited when manual damping (procedure TBD_{INST}).

5.6.1.1. Structural Tests

During the actual vibrations the scan motor shall be switched on.

For vibration testing the following items shall be *removed* from the instrument :

- scan cavity dust cover
- cooler dust cover
- contamination witness mirrors (TBC_{INST})

5.6.1.2. Thermal Tests

For thermal vacuum testing the following items shall be removed from the instrument :

- scan cavity dust cover
- cooler dust cover

5.6.1.3. EMC / RF-C Tests

For EMC/RFC testing the following items shall be removed from the instrument :

- scan cavity dust cover
- cooler dust cover

The maximum magnetic flux experienced by the instrument shall not exceed 2.0 gauss and the instrument shall not be exposed to a radiated electric field greater than one volt/meter for frequencies between 150 kHz and 500 MHz.

56.2. Function and Performance Tests (at PLM and System Level)

The following descriptions shall provide a. better understanding of the system level tests and are to be understood as for information only.

The test configuration is as per Table 5.3.2-1.

5.6.2.1. System Functional Tests (SFT)

The system functional test will verify the overall system performance and operability in a series of mission relevant modes. Back up modes, degraded modes and mode transitions will be included The SFT procedures will be composed of control files which have been validated during IST's.

5.6.2.2. Special Performance Test (SPT)

SPT's serve to execute specific performance verifications in the overall system configuration for atl those parameters which have contributions from more than one subsystem or for test cases which require a special set-up and operation condition. A typical example is a bit error performance test which involves elements of data acquisition, formatting and transmission.

For the instrument it is assumed that full performance hasbeendemonstratedaspartoftheinstrument acceptance test program, and therefore no instrument specific performance testing is required on system level.

5.6.2.3. Abbreviated Functional Tests (AFT)

The abbreviated function test is composed of a subset of control files and procedures from the system functional test. Its purpose is to demonstrate system integrity after major set-up changes and after transport. No measurement data evaluation will be included in the AFT's but only a verification that the measurement data streams are present. Therefore, no instrument stimulus generation and feedback data acquisition will be done.

5.7. INSTRUMENT CONSTRAINTS ON GROUND ENVIRONMENTAL CONDITIONS TBC

5.7.1. AIT Site

AVHRR/3, when held by handling fixture, may be positioned in any orientation.

The test connector cover for JO7 is considered as a flight hardware and shall remain installed at all times.

The scan cavity dust cover shah be installed at all times except when the instrument is in the thermal vacuum or vibration testing. The dust cover on the radiant cooler shall be installed at all times except when the instrument is in the thermal vacuum or vibration testing or when the bench test cooler is installed.

Connector dust caps shall be installed when the instrument is not in use.

During bench cooler operations, an exhaust line or filter, provided by METOP, shall be installed on the bench cooler vacuum pump exhaust.

5.7.2. Launch Site

Temperature, humidity and cleanliness conditions to which the instrument is exposed while at launch site are to be equivalent to those of the AIT site. Scan cavity and cooler dust covers shall be installed at all times. In the event that these covers are removed for an inspection of the scan mirror or cooler surfaces, the instrument shall be in class 100,000 or better clean area as defined in FED-STD-209B. In the event that it may not be possible to maintain the entire launch site ares in which the instrument is located to the clean conditions given above, the instrument shall be bagged to prevent contamination.

5.73. Transportation

To avoid damage to the instrument, when not. yet integrated to the spacecraft. it shall be hand-carried by authorized personnel in a sealed container, pressurized with dry N_2. For transport monitoring shock and temperature recorders integrated into the transit case shall be used.

5.7.4. Storage

For instrument storage the sealed containers shall be back-filled with dry N_2 to one atmosphere. Purging is not required.

The storage temperatures shah be as per § 2.3.2.1.

The humidity limits shah not exceed 90 percent when the instrument is in the shipping container and sealed. When the shipping container is open, the humidity limit is less than 55 percent. Under no conditions shall the humidity be allowed to approach the dew point.

Other maintenance, as for example re-calibration, is not planned during storage.

5.8. LAUNCH CAMPAIGN TBC

5.8.1. Launch Preparation

Check-Out on the Launcher

Instrument launch operations before encapsulation of the satellite into the launcher fairing will be a series of functional tests as already done during the AIT phase. After encapsulation of the satellite, there will be only limited command and control access via umbilical to the service module and the payload module avionics. Therefore, instruments will generally not be operated after spacecraft encapsulation. However, the AVHRR/3 scan motor shall be powered during lift off.

During launch preparation the alignment mirrors (2 off) have to be taped with a low reflectivity tape for stray-light suppression reasons. Furthermore it has to be assured that the test connector cover is installed.

58.2. Red Tagged Items

- Dust covers on scan cavity
- Dust covers on cooler
- connector dust caps